DOES NOT CIRCULATE

VOLUME LXV OCTOBER, 1955 NUMBER 10

UNIVERSITY OF MICHIGAN
NOV 11 1955
MEDICAL LIBRARY

THE LARYNGOSCOPE

FOUNDED IN 1896
BY
MAX A. GOLDSTEIN, M.D.

PUBLISHED BY
THE LARYNGOSCOPE
640 SOUTH KINGSHIGHWAY ST. LOUIS (10), MO., U. S. A.

MEDICAL HORIZONS TV Monday P.M.
Sponsored by CIBA
ASC-TV

Introducing . . .

greater safety

in topical anesthesia

Pyribenzamine® Anesthetic Solution and Jelly

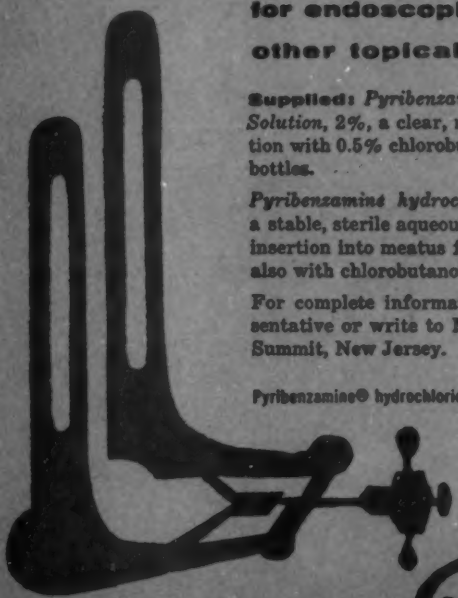
for endoscopic procedures and other topical anesthetic uses

Supplied: *Pyribenzamine hydrochloride Anesthetic Solution*, 2%, a clear, nonviscous, stable, sterile solution with 0.5% chlorobutanol as preservative; in 1-oz. bottles.

Pyribenzamine hydrochloride Anesthetic Jelly, 2%, a stable, sterile aqueous jelly with applicator tip (for insertion into meatus for intra-urethral instillation), also with chlorobutanol; in 1-oz. tubes.

For complete information, consult your CIBA representative or write to Medical Service Division, CIBA, Summit, New Jersey.

Pyribenzamine® hydrochloride (tripelennamine hydrochloride CIBA)



CIBA Summit, N. J.

THE
LARYNGOSCOPE.

VOL. LXV OCTOBER, 1955. No. 10

SURGICAL PATHOLOGY OF CANCER OF THE LARYNX.*†

JOSEPH H. OGURA, M.D.,

St. Louis, Mo.

INTRODUCTION.

Since malignancies of the larynx are usually resectable, surgical success is principally limited by metastatic disease and local recurrences. Likelihood and location of local metastases, therefore should determine the extent of the surgical procedure. Recently, Italian[7,78] and South American[28,89] authors have attributed their improved surgical results to the employment of more radical procedures in relatively earlier stages of cancer of the larynx.

They have demonstrated that metastases often occur earlier than had previously been appreciated. Since their studies were not reported in detail, it seemed highly desirable to undertake a pathologic study of specimens removed following laryngectomy and radical neck dissection, in order to reach a better understanding of the problem confronting the surgeon.

In the area of pathology of carcinoma of the larynx it is unfortunate that most previous discussions have been confined primarily to the larynx. On occasion, some attention has been given to the thyroid cartilage, the pre-epiglottic

* From the Department of Otolaryngology, Washington University School of Medicine.

† Submitted as Candidate's Thesis to the American Laryngological, Rhinological and Otological Society, 1955.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, July 5, 1955.

space and the immediate structures about the larynx, but their invasion has not been related to metastases in the lateral cervical lymph nodes.

Lymphatic spread into the deep cervical nodes has been thought to occur late, or rarely from intrinsic carcinoma of the larynx, and commonly only from the extrinsic variety. Disagreements and variations in classification, in specific selection of only ideal cases for treatment and in methods of study used, have made it difficult to correlate and evaluate the facts and opinions about cancer of the larynx. It is the opinion of the writer that the incidence and area of impalpable metastases from various local sites are frequent and wide, and that, from a surgical pathologic study of the local lesion, certain predictions may be made regarding the likelihood of metastases in the cervical lymphatics.

REVIEW OF THE LITERATURE.

During the past seventy-five years the literature on laryngeal carcinoma has been concerned mainly with diagnosis, surgery or radiotherapy, long term results and in only general terms with pathology. Nearly all of the earlier articles,[16,17,22,31,40,41,86,87,102] and both early[11,50,61,62] and recent[3,8,29,42,43,51,96] textbooks on otolaryngology have emphasized descriptions of the site of origin, have recognized that epidermoid carcinoma is the commonest malignant tumor, and have stressed differences in general pathologic behavior between intrinsic and extrinsic carcinoma of the larynx.

Classification.—Krishaber,[49] in 1879 first used the term "intrinsic" to include tumors on the laryngeal surface of the epiglottis and on the true and false cords. St. Clair Thomson[93,94,95,96] further restricted the term to include only tumors occurring on the true and false cords and in the ventricle, while Walsh[99] used it to refer to tumors only on a freely movable true cord.

Semon[86,87] introduced the term endolaryngeal for all tumors within the larynx, and Walsh[99] restricted it for tumors on the true and false cords and in the ventricle. The term subglottic was mentioned by Morrell McKenzie,[62] in 1880, as "vocal cord and subglottic region", but it was not until 1930 that St. Clair

Thomson recommended that the classification of subglottic cancer be differentiated from intrinsic, because of its different behavior.

Both early[11,50] and recent[2,43,96] textbooks on otolaryngology have referred to a lesion located on the epiglottis, the arytenoepiglottic fold, and in the pyriform sinus, as extrinsic carcinoma of the larynx. The term laryngo-pharyngeal cancer, for pyriform sinus carcinoma has been popular in Europe[14,39,45,78,81] and South America.[9,28,89]

Diagnosis.—The first positive diagnosis by biopsy of the larynx and histo-pathologic examination was made by Morrell McKenzie.[62] For years, many laryngologists[58,59,60] opposed biopy for fear of spreading the cancer and of making a benign growth malignant. Jackson[40,41] felt that biopsy and histologic examination were the only certain way for diagnosis. By 1926 the necessity of biopsy became universally accepted.

Grade.—Broders[10] in 1920 emphasized the importance of grading. The following statements epitomize the many assertions that have been made about the degree of differentiation.[1,2,24,26,27,34,42,45,55,63] "An undifferentiated tumor responds better to irradiation than a well differentiated carcinoma." or a "well differentiated tumor is more amenable to surgery than an undifferentiated carcinoma".

It has been pointed out by Jackson[42,43] that apart from the peculiar lymphatic distribution of the true vocal cord, a Grade I or II biopsy material from the cordal region does not necessarily represent the state of the entire tumor. Frequently the advancing margins are more undifferentiated, and anaplasia is often associated with lymphatic invasion. New and Fletcher[70] showed that the more undifferentiated the tumor, the further the tumor extended beyond the apparent normal margin. At the present time the grading of tumors is significant only to the extent that it is related to other factors.

Type.—About 95 per cent of the carcinomas occurring in the larynx are epidermoid or squamous cell variety.[1,2,17,21,29,42,47,64,81] (In Europe[15,39,56,64,78,81] and South America[9,66] these are

referred to as epitheliomas, spino-cellular variety). The remainder are composed of the basal cell and alveolar variety.

Location of Primary Lesion. — Many authors[19,22,23,32,33,42,46,52,58,59,84,97,98] have stated that the common site of origin of true cordal tumors was on the upper surface of the anterior two-thirds. The order of frequency of the remaining primary sites was the base of the epiglottis, anterior commissure, arytenoid, ary-epiglottic fold and pyriform sinus.[58,59]

Local Limiting Structures.—It has been stated that the cartilaginous structure of the larynx[43,56] limits the spread of cancer into the lateral neck. Breakthrough of cancer anteriorly through the thyroid cartilage has been mentioned by McKenty,[59], Le Roux-Robert,[56] Frazer,[32] Broyles[12] and Jackson.[42] Broyles[12] emphasized that the anterior commissure tendon was the commonest route of the thyroid cartilage invasion by carcinoma. Other cartilaginous structures may be invaded by malignancy.

Destruction of the epiglottic cartilage by carcinoma and invasion of the pre-epiglottic space has been mentioned by Le Roux-Robert,[56] Caliceti,[15] Clerf[19] and Bisi.[4] The importance of the limitation of cancer by the pre-epiglottic space has been emphasized by these authors. Le Roux-Robert[56] pointed out the rarity of involvement of the cricoid and arytenoid, and Terracol[91] wrote of an instance where the arytenoid cartilage was infiltrated by cancer.

Local and Other Spread.—Le Roux-Robert[56] presented a lucid account of the various sites of origin of laryngeal cancer, and its mode of local spread. He pointed out that subglottic tumors do not ordinarily invade the supraglottic area and vice versa.

Subglottic tumor is an infiltrative neoplasm and it often displaces intact mucosa but seldom infiltrates the arytenoid cartilage. Supraglottic tumors, *i.e.*, epiglottic carcinomas, not only invade the pre-epiglottic space, but also extend into the ary-epiglottic fold. Strictly unilateral false cord and ventricular tumors, which are unusual, may become bilateral and extend superiorly, but usually extend minimally inferior to the cord.

Snitman[85] demonstrated surface extension and infiltrative characteristics of cancer on the true cord, and he showed by serial sections how cancer on one true cord can grow on the surface to the anterior commissure, then down the opposite cord. Hassin,[38] pointing out that the infiltrative nature of the carcinoma of the true cord caused degenerative changes in the muscle fibers, believed that this, rather than a nerve involvement, was the main cause for fixation of the vocal cord.

Immediate direct extralaryngeal soft tissue involvement by cancer has been observed by other authors.[59,72,73,75] Involvement of such structures as the pretrachael and prelaryngeal muscles and thyroid are not infrequently noted.

Lymphatics.—Semon[86] attributed infrequent spread of cancer from the true cord to the poor lymphatic supply of the vocal cord. Nodal metastases from carcinoma of the larynx have long been recognized to occur with high frequency in the extrinsic form and very infrequently or rarely with carcinoma, limited to the true cord.

Extensive and detailed studies of the lymphatic supply of the larynx have been described by many authors.[36,69,80,83] The supraglottic structures are drained by lymphatics which accompany the superior laryngeal vessels. The infraglottic structures are drained by lymphatics, which course anteriorly to the prelaryngeal node or laterally through the cricothyroid membrane to the paratracheal or deep cervical nodes. The deep cervical nodes are eventually reached by drainage from above and below the true cords.

It has been mentioned that differences in classification of intrinsic and other carcinomas within the larynx, lack of standardization of terminology, and variation in methods of treatment have made it difficult to evaluate the frequency of cervical metastases. Taylor and Nathanson[90] have stated that metastases from "intrinsic" cancer are rare, but they do not mention subglottic cancer. Only recently, other authors[20,72,73,75,76] have emphasized the likelihood of lymphatic metastases from subglottic cancer.

The surgical results of early cancer restricted to the true cord (intrinsic) have been good[30,42,44,52,53,54,67,93] with a 85-93 per cent recovery by the transoral or laryngo-fissure route. The

incidence of metastasis from movable true cordal cancer has been low and reported variously from 4 to 15 per cent.[5,44,76,78]

From the literature it has been difficult to determine the exact incidence of cervical metastasis from intrinsic cancer, since local recurrences and metastases have frequently been reported together. The reported high cure of intrinsic cancer has been related to tne low metastatic incidence from tumors on the true cord.

The situation has been quite different with advanced laryngeal carcinoma. The principal cause of failure in more advanced cancer treated by laryngectomy alone has been due to "local recurrences" and to cervical metastases,[5,18,20,21,43,47,52,63,65,71,85,98]. As a result, radical neck dissection and laryngectomy at first in two stages and later in one stage, have been done.[6,8,13,21,25,47,57,65,68,72,73,75,76,78,79,89,101] Many authors[7,9,21,28,72,73,75,76,78,79,89] have recently advocated elective or prophylactic neck dissection with laryngectomy on the basis that impalpable metastases were present in a high incidence. The writer, however, has been unable to find any published reports on a series of consecutively operable cases of laryngeal carcinoma, with and without palpable nodes, that has been subjected to detailed pathologic analysis.

OBJECTIVES.

The objectives of the present study are:

1. To classify and to study the characteristic features and mode of local spread of primary laryngeal carcinoma.

2. To correlate site of primary lesion with incidence and location of palpable and impalpable metastases in the lateral cervical lymphatics.

3. To study invasion of cancer in the thyroid cartilage and in the pre-epiglottic space with respect to the incidence of nodal metastases.

4. To relate the incidence and association of cancer in prelaryngeal nodes with tumor in the lateral cervical lymphatics.

5. To study infiltration of cancer in the immediate extralaryngeal soft tissue structures, the thyroid gland, the sterno-

thyroid and sternohyoid muscles, and the prelaryngeal and paratracheal nodes.

The data derived should lead to pertinent conclusions relating to surgery of laryngeal carcinoma.

METHOD OF STUDY.

Selection of Specimens.—The material obtained for study consisted of 59 specimens for *en bloc* laryngectomy and neck dissections in consecutive unselected patients with endolaryngeal, subglottic and extrinsic carcinoma of the larynx, from 1948 to 1954. The specimens obtained were divided according to whether neck dissection was therapeutic* or elective**.

Unilateral therapeutic or elective neck dissection was done when the tumor was confined to one side, or had just crossed the midline. Bilateral neck dissection was done only if the local lesion was extensive and bilateral, *i.e.*, in epiglottic carcinomas. There was no selection of patients for irradiation therapy first, unless this therapy was given elsewhere and the tumor persisted, or surgery was contraindicated.

It should be pointed out that 12 who had separate operations of laryngectomy and neck dissections were omitted. Ten of these were the operations performed before the development of the one-stage operation. The remaining two represented therapeutic neck dissection long after laryngectomy. These two were observed during the same period as the 59 for which the one-stage operation was performed.

One of the two should have had an elective neck dissection at the time of laryngectomy, but further surgery was deemed inadvisable because of the poor condition of the patient. In the other case, laryngectomy was thought to be sufficient because the paretic cord was adjudged to be movable; that is, a cord without muscle invasion, but a year later secondary neck dissection became necessary.

Early cancer restricted to movable true cords was excluded from this study; *e.g.*, intrinsic cancers ideal for transoral or

* Therapeutic neck dissection refers to surgery for clinically positive nodes.

** Elective neck dissection refers to surgery in the absence of palpable nodes.

laryngo-fissure, and bilateral cordal carcinomas treated by wide field laryngectomy alone.

The present contraindications for surgery constituted another group excluded from this study. They are: *1.* Fixed, matted cervical mestastases. *2.* Anaplastic carcinoma (Grade IV by biopsy) with palpable adenopathy low in the neck. *3.* Bilateral large cervical metastases, despite mobility. *4.* Demonstrable distant or pulmonary metastases. *5.* Extremely poor surgical risks. *6.* Refusal of surgery.

Examination of Material. — The larynx was immediately split posteriorly in the midline of the cricoid cartilage and into the inter-arytenoid area, and then it was held apart and photographed. The larynx and lymph nodes were studied in the following manner:

Larynx.—The exact shape, extent, size and surface characteristics of the tumor in the larynx were drawn to full scale from the superior or mirror view, posterior view with cricoid cartilage split, sagittal view, and frontal view.

The local lesion was examined grossly and microscopically for the following features: Ulceration and infiltration, fungation and infiltration, exophytic or papillary structure, mucosal and submucosal displacement, type and final grade of the tumor, lymphatic, perineural lymphatic and vascular invasion.

Sagittal section, which included the hyoid bone, the first tracheal ring and the intervening structures was made. Tissues were uniformly taken for sectioning for microscopic examination. Multiple vertical stepwise sections of the pre-epiglottic space and the anterior thyroid and cricoid cartilages were made. Transverse or vertical sections of the arytenoid eminences, including the pyriform sinus were taken.

Several sections in various planes of lesions of the true and false cords and subglottic areas were taken. The superior, lateral, inferior and medial margins of tumors of the epiglottis, aryteno-epiglottic fold and pyriform sinus were also taken. Sections were prepared of the thyroid gland and the sternohyoid and sternothyroid muscles.

The conventional method for decalcifying cartilage and

bone with formic acid was used, and sections were stained with hemotoxylin and eosin.

Lymph Nodes.—After the nodes were removed and studied, they were plotted on a full scale drawing of the neck and grouped, according to their location as follows:

1. Anterior triangle.
    a. Submental.
    b. Submaxillary or digastric (between mandible and anterior and posterior belly of digastric muscle).
        1—Superior internal jugular (most superior node along the internal jugular vein).
        2—Jugular-digastric.
    c. Superior triangle (between sternomastoid, omohyoid and digastric muscles.
        1—Middle internal jugular (between digastric and omohyoid muscle).
        2—Parotid.
    d. Inferior triangle (between sternocleidomastoid and omohyoid muscles and the midline).
        1—Prelaryngeal.
        2—Paratracheal (posterior and medial to the thyroid gland).
        3—Jugular-omohyoid.
        4—Inferior internal jugular (lowest node along internal jugular vein).
2. Posterior triangle (between sternocleidomastoid muscle, clavicle and trapezius muscle).

All nodes were fixed in 10 per cent formalin as one of the above groups for 24 hours, split in their long axes, and examined for tumor characteristics. Occasionally, the tumor was obvious or suspicious in the peripheral sinusoids of the impalpable nodes.

Saphir[82] has shown that serial sections of axillary nodes previously reported negative will often reveal carcinoma. Initially, it was our practice to make many sections at various depths on a tissue block for each node; however, it was not possible to carry out serial sections of every node in a project of this size. An approximation was achieved by making two sections: one was superficial, and another was deep of several previously multidivided nodes mounted on a single tissue block. When the characteristic gross features of the node revealed tumor, only a single section was made.

CLASSIFICATION.

Primary Lesion.—The clinical criteria for the classification of laryngeal carcinoma suggested by Walsh[99] were employed in this study. Clinical observations of the larynx may not always correlate with what is seen at operation, or on histologic section. It is well known that tumors visualized indirectly, or even by direct laryngoscopic methods, are often found to be much more extensive after surgical excision than expected. Thus, a few carcinomas thought to be of endolaryngeal origin prior to surgery are actually found to be the subglottic or extrinsic type; therefore, final classification of the specimens was based upon the findings of pathologic examination.

Endolaryngeal.—Endolaryngeal lesions are limited to the true and false cords and ventricle (see Fig. 1). The free border of the true vocal cord represents the inferior boundary, and an arbitrary line along the most superior border of both false cords constitutes the upper limit. A small area of the extreme base of the epiglottis is included where there is an area of union of the false cords and the posterior limit is the body of the arytenoid cartilage.

The vocal process will fall within the endolaryngeal area. When subglottic extension of only a few mm. beneath the true vocal cord occurs the classification has been endolaryngeal. Actually, our present term *endolaryngeal* refers to the old St. Clair Thomson terminology for intrinsic cancers. In the present classification the term *intrinsic* refers only to cancer restricted to the mobile true cords.

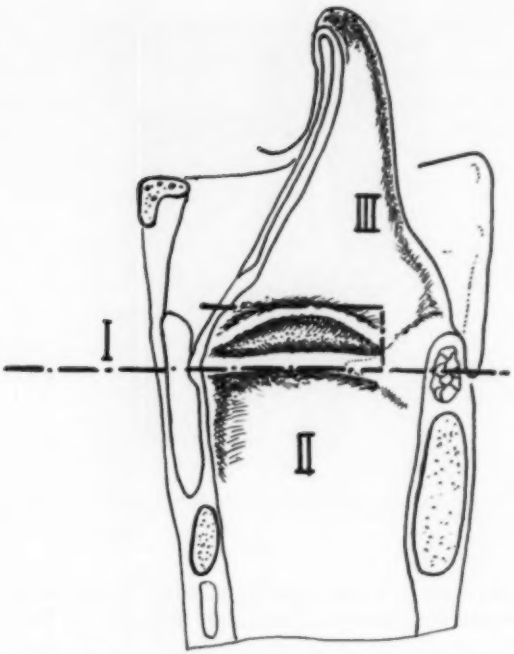


Fig. 1. Classification of carcinoma of the larynx. I—Endolaryngeal; II—Subglottic; III—Extrinsic.

Extension of the tumor by the mucosal or submucosal routes into the aryepiglottic fold or further into the base of the epiglottis, into the pyriform sinus or the arytenoid eminence places the lesion in the extrinsic classification. In two instances in the writer's series, the lesion was extensive, involving the base of the epiglottis, the cords and the subglottic areas. In such areas, the center of the lesion was taken to be the primary site. In one of two instances, the tumor was classed as epiglottic, and in the other definitely as subglottic.

Le Roux-Robert[56] used the term "vestibular carcinoma" to include tumor on the base of the epiglottis and the false cord, *i. e.*, the inferior half of the epiglottis. Pietrantoni, et al.[78] used the same term to include the entire base of the epiglottis and the arytenoid area as well (see Fig. 2). To avoid con-

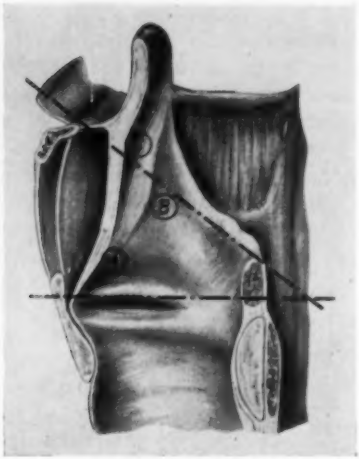


Fig. 2. Vestibular Carcinoma (from Pietrantoni, et al.) A—Inferior vestibular carcinoma; B—Superior vestibular carcinoma; C—Epiglottic carcinoma.

fusion this term was not used here, since malignancies of this region would overlap what this study refers to as the extrinsic area.

Subglottic.—Subglottic lesions are confined beneath the true cords (see Fig. 1). The superior margin of the tumor may extend to the free border of the cord and displace the floor of the ventricle superiorly. Carcinoma of the true vocal cord that extends for a millimeter or two beneath the cord is not a true subglottic lesion. The inferior border of the cricoid cartilage constitutes the lower boundary of the subglottic area, and a primary lesion below the cricoid is considered to be tracheal in origin.

Extrinsic.—Extrinsic lesions involve the base of the epiglottis, aryepiglottic fold, pyriform sinus, or the arytenoid eminence (see Fig. 1). Post-cricoid carcinoma is not included in this study, as this lesion represents an esophageal carcinoma.

Cervical Nodes: Definition of Clinically Palpable and Clinically Negative Nodes.—Pre-operatively, nodes in the neck

are either impalpable or clinically palpable, *i. e.*, clinically positive. Histologically, firm palpable nodes almost always show cancer. Small nodes that contain carcinoma are often "just palpable" or "questionably palpable." In most instances, the diagnosis was confirmed and justified the clinically positive classification, and will be referred to in the tables as *palpable-positive.*

Impalpable lymph nodes, or nodes that are "questionably" or "barely palpable" and are microscopically negative, were grouped as clinically negative and microscopically negative *(impalpable-negative).* Clinically impalpable nodes that were microscopically positive *(impalpable-positive),* are instances where there was not even a suggestion of a node to palpation, and the true nature was revealed only by a systematic pathologic examination. Except for the prelaryngeal and paratracheal nodes, for purposes of tabulation in the illustrations, the demonstration of two or more microscopically positive nodes in one or both sides of the neck dissection specimen was listed only once.

RESULTS.

Laryngeal Lesion: Endolaryngeal Carcinoma.—There were 18 endolaryngeal carcinomas in this group, with eight on a fixed true cord, seven on both the true and false cords, two on the false cords, and one in the ventricle. A typical example of endolaryngeal carcinoma is illustrated in Fig. 3.

The site of origin of carcinoma of the true cord was usually found on the free or upper surface of its anterior one-third. While carcinoma remained localized to this portion for some time, it extended anteriorly to the anterior commissure, superiorly and anteriorly to the false cord junction and into the ventricle and posteriorly to the vocal process (see Fig. 4).

Further mucosal spread at the anterior commissure onto the surface of the opposite cord for 1 to 2 mm. and into the subglottic area frequently occurred. In two instances the tumor arose from the anterior commissure, but predominated more on one side or the other by the nature of its advancing border, or its type of attachment.

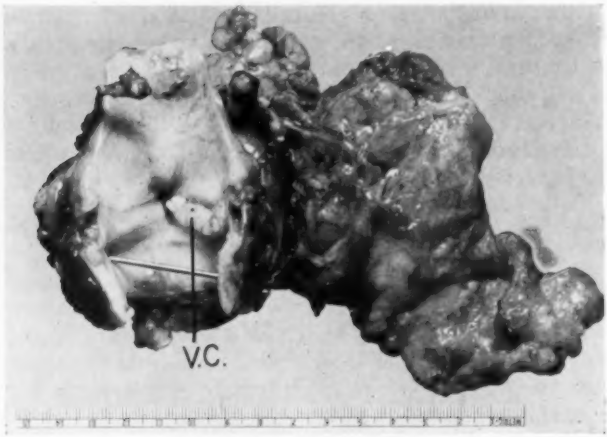


Fig. 3. A typical specimen of endolaryngeal carcinoma. The true cord was fixed, and the cervical nodes were negative. VC—True vocal cord. (This patient is alive and free of disease three years after surgery.)

Fixation of the true vocal cord was due to deep invasion of the intrinsic muscles by tumor, rather than to invasion of

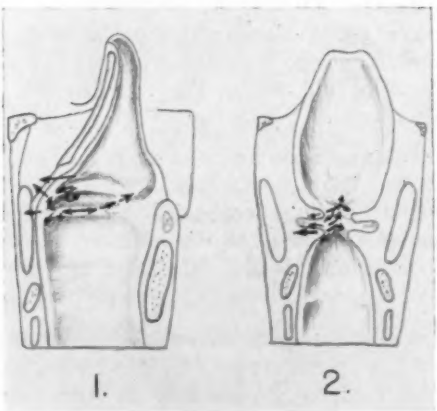


Fig. 4. Local spread and extension in endolaryngeal carcinoma. 1. Sagittal section—Three arrows indicate the route of possible extension into the thyroid cartilage and the pre-epiglottic space. 2. Frontal section, anterior view.

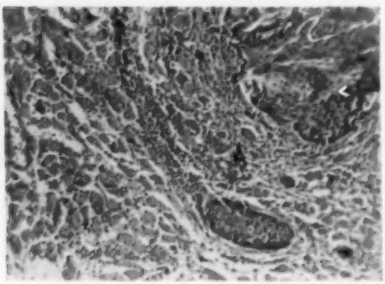


Fig. 5. Note the zone of degenerating muscle fibers, A, located between normal muscle and tumor.

the arytenoid cartilage. There was loss of striations, fragmentation and degeneration, lysis of the muscle fibers and a varying degree of round cell infiltration (see Fig. 5). Frequently, lymphatic invasion was noted in the intrinsic muscle area (see Fig. 6).

Tumor often was found spreading submucosally to the lateral border of the ventricle adjacent to the thyroid cartilage, and in its posterior extension along the vocal cord was often observed about the vocal process (see Fig. 7).

In two of eight instances, there was erosion and destruction of the anterior thyroid cartilage. The pre-epiglottic space was not invaded in any instance.

In all seven cancers of the true and false cords, the lesion was predominantly unilateral. The area of invasion was the

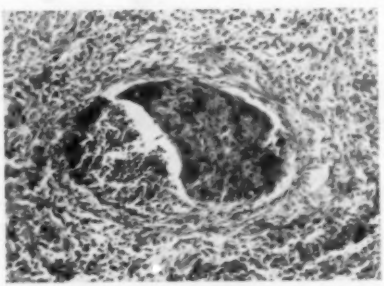


Fig. 6. Tumor with a vascular channel of the intrinsic muscles.

anterior two-thirds of the superior portion of the true cord, and the anterior half of the false cord. That area of the extreme base of the epiglottis where the false cords unite anteriorly is frequently involved, and five of the seven crossed the anterior midline by a few millimeters.

Extension generally took place into the anterior ventricle but did not involve it entirely. In every instance there was infiltration of the intrinsic muscles of the true cord. Occasionally, surface or superficial subglottic extension occurred for 1 to 3 mm. at or just posterior to the anterior commissure. In four of seven, there was invasion of the anterior thyroid

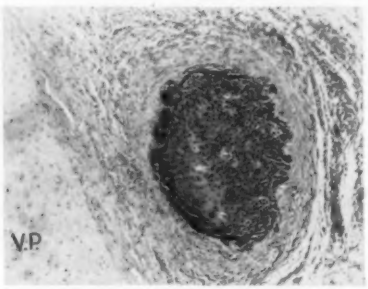


Fig. 7. Cancer adjacent to the vocal process of the arytenoid cartilage. VP—Vocal process.

cartilage, and in three of seven, into the pre-epiglottic space at its extreme apex. In three of the four, simultaneous invasion of both structures was present.

In two unusual instances carcinoma was restricted to one false cord. In one, invasion of the anterior thyroid cartilage, as well as into the lateral portions of the pre-epiglottic space occurred.

Carcinoma of the ventricle was found only once. The false cord was displaced medially and slightly upwards by a bulky ventricular mass, which histologically was the only one of the endolaryngeal group with a ductal or acinar pattern. Destruction of the anterior thyroid cartilage was not present, but invasion of the lateral pre-epiglottic space was demonstrated.

Sixteen endolaryngeal tumors showed gross characteristics

of ulceration, fungation and infiltration. Two of 18 endolaryngeal cancers revealed an exophytic structure; however, one of the latter two was infiltrative and invasive in the deeper tissue. Intermediate Grade II and III predominated, and only one was Grade IV. It was frequently observed that when the biopsy specimen was Grade II, the advancing border of the tumor was Grade III.

Invasion of the anterior thyroid cartilage was commonly observed, and occurred in seven of 18 endolaryngeal tumors,

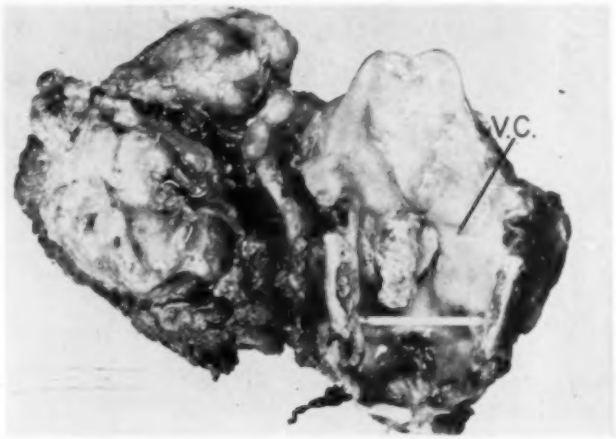


Fig. 8. A typical specimen of subglottic carcinoma. A solitary impalpable metastasis was demonstrated at the jugular-omohyoid area. VC—True vocal cord. (This patient is alive and free of disease four and one-half years after surgery.)

while the hyoid bone and the cricoid and arytenoid cartilages were never invaded. Immediate extralaryngeal soft tissue involvement was infrequent; invasion of the sternohyoid and sternothyroid muscles occurred once, and the thyroid gland was invaded twice.

Subglottic Carcinoma.—There were 13 subglottic lesions in the group, of which ten were unilateral and three were bilateral. In the latter, one side predominated, and there was extension anteriorly to the lesser side for 3-4 mm., and one, for 10 mm. Of the ten that were unilateral, two just

crossed the anterior midline by 1 to 2 mm. at the most. The remainder of the group were strictly unilateral (see Figs. 8, 9).

Except for one instance which was exophytic, the remainder were ulcero-fungating in the center of the lesion, and the advancing margins invaded the intrinsic muscles of the true cord, and frequently displaced intact mucosa near the free border of these cords. This produced the effect of a thickening of the true cord, and its fixation was due to invasion of its intrinsic muscles.

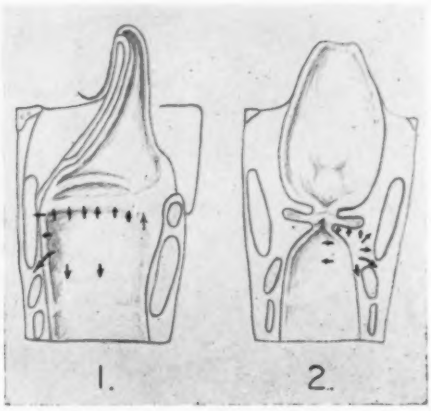


Fig. 9. Local spread and extension in subglottic carcinoma. 1. Sagittal section. 2. Frontal section, anterior view. (Note arrow that extends into the cricothyroid membrane.)

The unilateral lesions had a center of origin 0.6 to 1.0 cm. midlaterally beneath the true cord. The bilateral lesion likewise occurred 0.7 to 1.0 cm. beneath the cords, but its center of origin was more anterior in position with respect to the lateral subglottic area.

Subglottic cancer quickly invades to the perichondrium of the thyroid and cricoid cartilages and always extended to and frequently through the cricothyroid membrane (three of 13). It may impinge upon or displace the cricothyroid membrane, and may infiltrate through it anteriorly or antero-laterally into the soft tissues of the neck (see Fig. 10).

In only one instance, the cricoid cartilage was partially invaded at its midsuperior border. Extension posteriorly across the midline seldom occurred, but on reaching the inferior arytenoid area tended to involve the perichondrium of the cartilage. There was absence of destruction of the arytenoid carti-

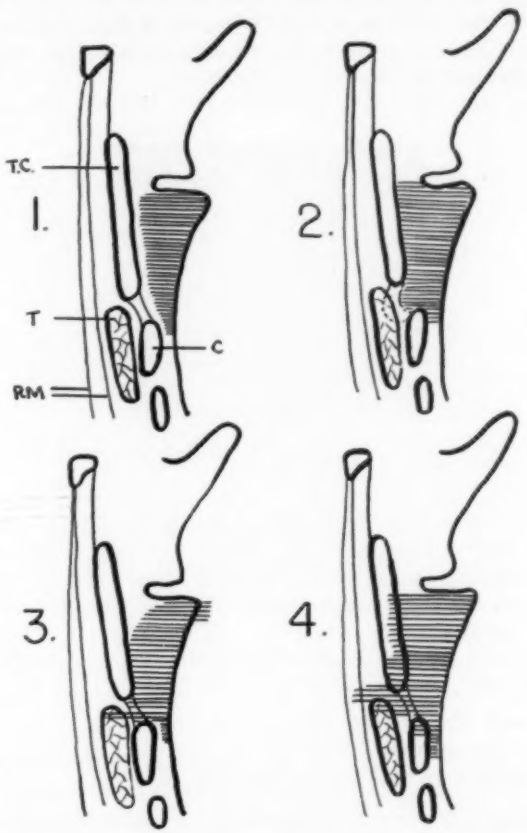


Fig. 10. Extension of tumor in subglottic carcinoma; sagittal views. 1. Tumor adjacent to perichondrium of the thyroid cartilage. 2. The cricothyroid membrane is displaced forward by tumor. 3. The isthmus of the thyroid is infiltrated by tumor. (A section lateral to this area may show invasion of the lateral lobe.) 4. Invasion of the thyroid and ribbon muscles. TC—Thyroid cartilage. C—Cricoid cartilage. T—Thyroid gland. RM—Sternothyroid and sternohyoid muscles.

lage. In one instance, the tumor extended above the arytenoid cartilage by "circling" around it.

Supraglottic invasion, mentioned above in the classification, was observed once. Erosion of the anterior thyroid cartilage by tumor was found once, invasion of the ribbon muscles opposite the anterior crico-thyroid membrane twice, and involvement of the thyroid gland twice. The infiltration of the pre-epiglottic space by tumor of subglottic origin was never demonstrated.

Fig. 11. Cancer within the lymphatic channels in the subglottic tissue adjacent to the cricoid cartilage.

Twenty-nine out of the 31 endolaryngeal and subglottic tumors were of squamous cell variety (93.6 per cent), and the remaining two were of the alveolar type. There was one adenocarcinoma in each group. Of the squamous cell type, the tumor was of intermediate grade, either II or III. Lymphatic invasion was frequently observed in the deep subglottic tissue (see Fig. 11).

Extrinsic Carcinoma.—Twenty-eight lesions were in the extrinsic group, with 16 in the pyriform sinus, eight on the aryepiglottic fold and four on the epiglottis.

Pyriform Sinus.—Pyriform sinus malignancies can be divided as arising primarily from its lateral wall, apex, or medial wall (lateral arytenoid eminence).

It was of little practical value to separate the tumors into these groups, since all three areas were involved to varying

degrees. A lesion primary in the lateral wall of the pyriform sinus always involved the medial wall (lateral arytenoid eminence) to a certain degree; likewise the reverse was also true. With involvement of the medial wall, the cord was frequently fixed.

Characteristically, these tumors were of the ulcero-fungating type and invaded in the following manner (see Figs. 12, 13): When the neoplasm was primary on the lateral arytenoid eminence, infiltration submucosally into the aryepiglottic fold soon caused marked broadening of the structure and distortion of the epiglottis.

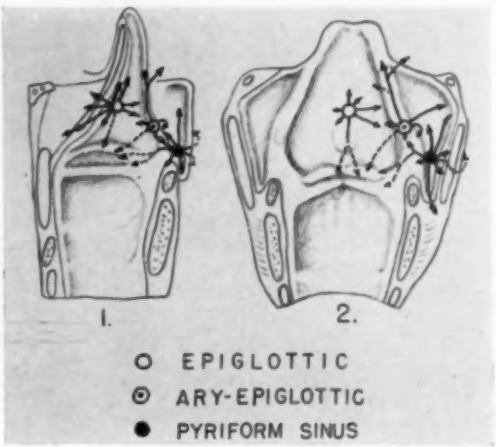


Fig. 12. Local spread and extension in extrinsic carcinoma. 1. Sagittal view. 2. Posterior view with the cricoid cartilage divided in the midline. (The dotted arrows indicate spread by the submucosal route. The dotted arrow in the pyriform sinus shows extension around the posterior border of the thyroid lamina.)

Further extension beyond the aryepiglottic fold into the glosso-epiglottic fold resulted with invasion into the base of the tongue. The thyroid cartilage and thyrohyoid membrane cannot efficiently restrict lateral extension, and superior extension into the laryngopharynx and on the posterior wall of the pyriform sinus always occurred.

When tumor spread posteriorly to the arytenoid, it readily

crossed the midline in the superior post-cricoid area: when it extended inferiorly to the arytenoid, there was infiltration of the wall of the upper esophagus. A portion of the apex of the pyriform sinus located between the firm structures of the thyroid and cricoid cartilage, will resist invasion; but the tumor can readily spread laterally around the posterior border of the thyroid ala to its external perichondrial surface.

Direct lateral extension of the tumor will not only place the cancer in immediate relation to the great vessels of the neck, but on occasions it will also invade the capsule of the superior

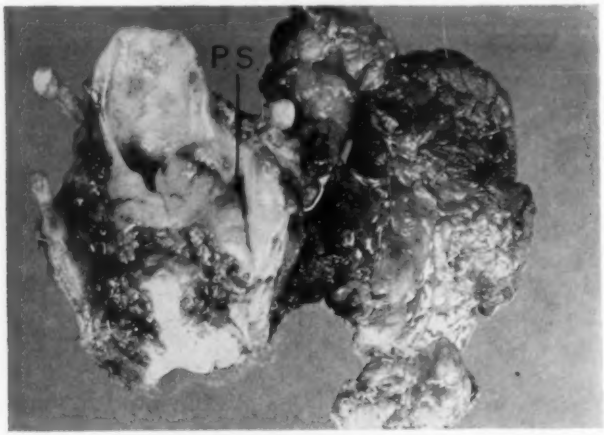


Fig. 13. A typical specimen of a pyriform sinus carcinoma. Note the deep ulcer in the apex of the pyriform sinus. This specimen was removed from a patient who was treated with irradiation and followed by surgery. The cervical nodes were negative. PS—Pyriform sinus. (The patient is alive and free of disease six years later.)

lobe of the thyroid gland (twice). Surprisingly, the lateral wing of the thyroid cartilage was invaded only once, and posterior invasion of the prevertebral fascia was not found.

The endolaryngeal structures, such as the ventricle, false cords and true cords are often secondarily invaded by the submucous "retrograde" route, but subglottic invasion was not demonstrated. The anterior thyroid, cricoid cartilages and the hyoid bone were not invaded in any instance. When the aryepiglottic fold was secondarily infiltrated, the lateral pre-

epiglottic space was occasionally invaded. Cancer often approached the arytenoid cartilages, but actual invasion occurred only once.

All of the tumors of the pyriform sinus were of the epidermoid variety, and Grade III predominated in this group. Perineural lymphatic and submucosal lymphatic invasion was frequently noted (see Fig. 14).

Aryepiglottic Carcinoma.—In five of eight, the free border of the aryepiglottic fold in the region of the cuneiform tubercle was the primary site of origin (see Fig. 12). Three of eight tumors had their center of origin closer to the aryepiglottic

Fig. 14. Note the numerous lymphatic channels in the submucosa and tumor within two of the vessels.

fold than the midbase of the epiglottis. These were classified as aryepiglottic in origin rather than epiglottic even though the edge of the tumor extended to the midline. All showed the surface characteristics of ulceration and fungation (see Fig. 15), except one which was of the exophytic type.

Infiltration submucosally took place towards the arytenoid eminence, on the laryngeal surface of the epiglottis and into the medial wall of the pyriform sinus. In seven of eight, the tumor manifested itself on one side of the epiglottic cartilage and in the lateral pre-epiglottic space. Usually the aryepiglottic fold was broadened and the epiglottis distorted.

With advance of the cancer, progression into the glossoepiglottic fold and the tongue resulted (see Fig. 16). Fre-

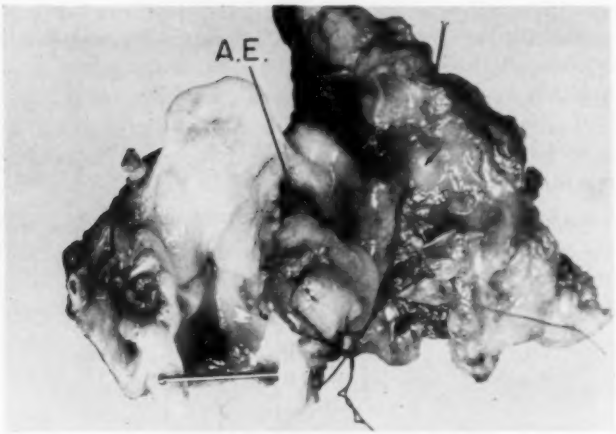


Fig. 15. A typical specimen of aryepiglottic fold carcinoma. Note the ulceration and infiltration extending into the pyriform sinus. The arrow points to a palpable cervical metastasis. AE—Aryepiglottic fold. (Subsequently the patient developed bronchogenic carcinoma and lived two years.)

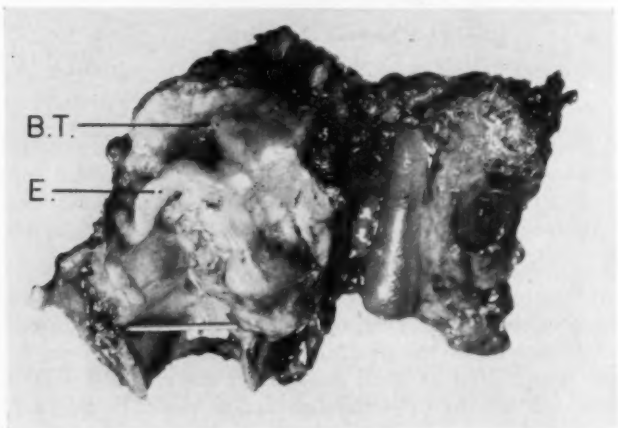


Fig. 16. A typical specimen of aryepiglottic fold carcinoma. Note the swelling of the aryepiglottic fold with distortion of the epiglottis, and extension into the base of the tongue. There were no positive nodes in the specimen. E—Epiglottis. BT—Base of the tongue. (The patient is alive and free of disease two and one-half years later.)

quently, submucosal invasion of the endolaryngeal structures (ventricle, false cord and true cords) occurred, but subglottic invasion was not demonstrated.

Seven of eight aryepiglottic fold cancers were of the epidermoid variety, and Grade II or III, while one was an adenocarcinoma. The arytenoid cartilage was often surrounded by the tumor close to the perichondrium, but cartilage was invaded only once (see Fig. 17). The hyoid bone, thyroid and cricoid cartilages were not involved.

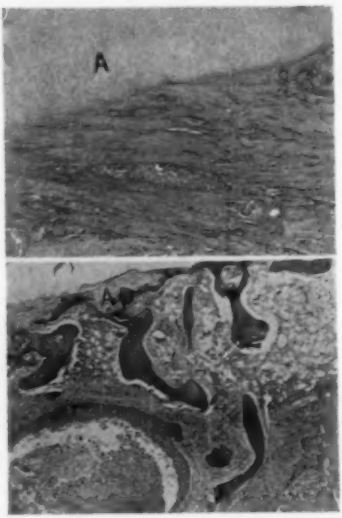


Fig. 17. The upper photomicrograph taken at low power shows carcinoma immediately adjacent to the perichondrium of the arytenoid cartilage, but there is no invasion of the cartilage. A—Arytenoid cartilage.

The lower illustration is a high power view, and shows cancer infiltrating and destroying the cartilage. AD—Destruction of arytenoid cartilage.

Epiglottic Carcinoma.—All four of the epiglottic carcinomas involved its base, most of the laryngeal surface of the epiglottis and to some degree its mobile portion (see Figs. 12, 18). Generally the tumor was midline in origin with predominant extension laterally either to right or to left into the aryepiglot-

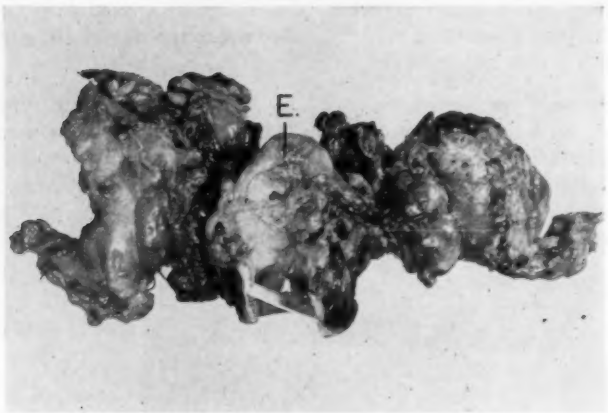


Fig. 18. A typical specimen of epiglottic carcinoma. E—Epiglottis. The faint dotted line delineates the margin of the tumor. There was one palpable node in the right lateral cervical area, and one impalpable metastasis in the left cervical area. (The patient is alive and free of disease three and one-half years later.)

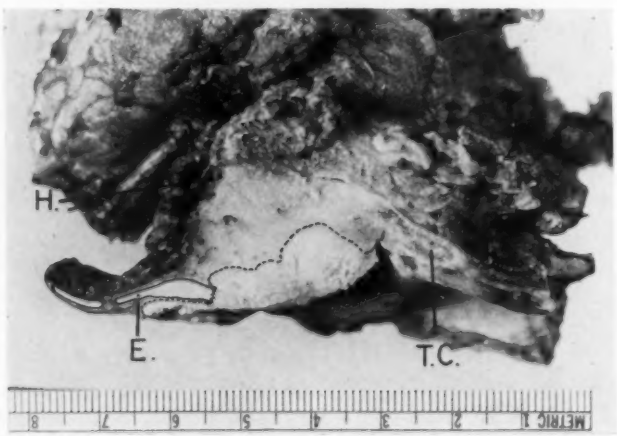


Fig. 19. Invasion of the pre-epiglottic space. Sagittal view of specimen illustrated in Fig. 18. The dotted line delineates the margin of the tumor in the pre-epiglottic space. Note the destruction of the epiglottic cartilage. TC—True vocal cord. H—Hyoid bone. E—Epiglottis.

tic fold. Both false cords were invaded, particularly their anterior portions, and to some degree, the ventricle.

All four tumors were of the ulcero-fungating type and invaded extensively the pre-epiglottic space anteriorly, superiorly and laterally (see Fig. 19). They may even displace the epiglottis posteriorly. The fenestrations of the epiglottic cartilage, which normally contain mucous glands, permit the tumor to extend into the pre-epiglottic space, and the cartilage itself is frequently destroyed (see Fig. 20).

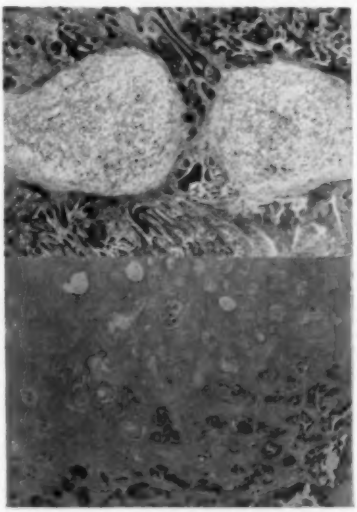


Fig. 20. The upper illustration shows cancer infiltrating into one of the fenestrations of the epiglottic cartilage. Tumor is on both sides of the cartilage. The lower figure shows cartilage destroyed by cancer.

The neoplasm appeared to be restricted within the defined boundary of the pre-epiglottic space, but in extensive lesions the external surface of the anterior superior margin of the thyroid cartilage was invaded once, and in two out of four instances, cancer infiltrated into the sternohyoid and sternothyroid muscles.

All four carcinomas of the epiglottis were of the squamous cell type and either Grade II or III. Subglottic invasion was

present in one of the four specimens. The hyoid bone, cricoid and arytenoid cartilage were not involved.

The general characteristics of extrinsic carcinoma revealed that 27 of 28 were of the ulcerating, fungating, and infiltrating type, and only one was of the exophytic type with minimal infiltrative tendency. Twenty-seven of 29 (96.4 per cent) were of the epidermoid type, and two were of the alveolar variety. There was a greater tendency for final Grade III in carcinoma of the extrinsic group than in the endolaryngeal group.

Other lesions of interest found in this series were one separate carcinoma *in situ* and two instances of hyperkeratosis of the true cord; one primary carcinoma of the lung and one of the pancreas, all found in association with extrinsic carcinoma of the larynx. Primary carcinomas of the esophagus and lung were found once, each associated with endolaryngeal and subglottic carcinomas, respectively.

TABLE I.
INCIDENCE OF CERVICAL METASTASES RELATED TO PRIMARY LESION.

Primary Lesion	Clinical and Histological Description of Cervical Nodes			
	Impalpable-Negative*	Impalpable-Positive*	Palpable-Positive*	No. of Specimens
ENDOLARYNGEAL				
Fixed True Cord	6	2	1	9
Fixed True Cord False Cord	2	2	2	6
False Cord	1		1	2
Ventricle			1	1
Totals	9	4	5	18
SUBGLOTTIC	6	6**	1	13
EXTRINSIC				
Pyriform Sinus	1	4	11	16
Aryepiglottic Fold	3	2	3	8
Epiglottis	2***	2***		4
Totals	6	8	14	28

* Negative and Positive denote demonstration or failure to demonstrate nodal mestastases. See explanation under Classification:
Definition of Clinically Palpable and Clinically Negative Nodes.
** Includes one bilateral neck dissection.
*** Includes three bilateral neck dissections.

Cervical Node Mestastases: Nodal Metastases from Endolaryngeal Carcinoma.—An average of 34 lymph nodes were removed, with a range of 20 to 42, from each of the specimens of unilateral neck dissections for endolaryngeal carcinoma. Of the 18 carcinomas, there were five associated with clinically *palpable* nodes, all homolateral to the primary lesion (see Fig. 21).

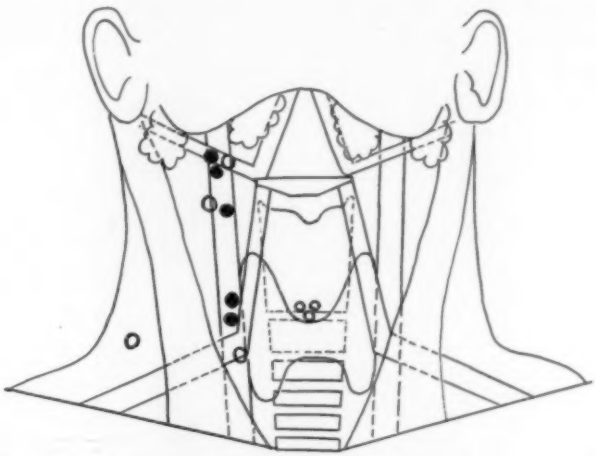


Fig. 21. Distribution of palpable and impalpable metastases in 18 endolaryngeal cancers. ●—Palpable metastasis. O—Impalpable metastasis. Each circle represents the location of the involved node. Negative findings are not in the illustration.

There was a scattering of nodes palpable in the deep jugular chain without any tendency to localize to one area. Two were palpated at the jugulodigastric area, one opposite the pyriform sinus, one by the inferior cornu of the thyroid and one by the cricoid cartilage. Each palpable node averaged 2 to 3 cm. in size, and in four of the five specimens, two or more impalpable nodes were also demonstrated immediately adjacent to the main palpable mass. In one of the four, a small node was found high in the submaxillary triangle, superior to the main palpable node.

In two instances, a microscopically positive paratracheal node adjacent to the medial and posterior surface of the thy-

roid gland was demonstrated. The submental nodes were negative.

In four of 13, an *impalpable* metastasis was found in a solitary lateral cervical node (31 per cent). Fig. 21 shows the location of the metastases at the jugular-digastric, pyriform sinus, jugular-omohyoid, and the posterior triangle areas. In

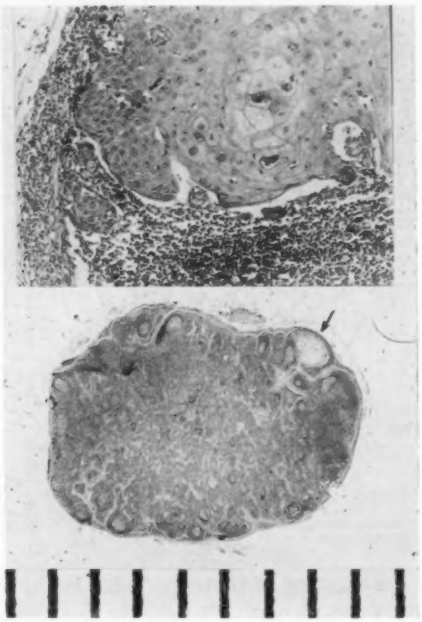


Fig. 22. The lower photomicrograph shows a small focus of metastatic carcinoma in the periphery of a deep cervical node measuring 0.7 cm. Each line at the bottom represents 0.1 cm. The upper illustration is a high power view of the area of the arrow.

addition, in three instances the prelaryngeal node was microscopically positive. The four impalpable nodes averaged 0.7 cm. in length with a variation in size from 0.5-1.3 cm. (see Fig. 22).

The three instances in which microscopically positive prelaryngeal nodes were demonstrated (average size 0.5 cm.)

were found to have positive nodes in the neck, twice as microscopic metastases in a solitary deep lateral cervical node and once as a small palpable cervical node.

Nodal Metastases from Subglottic Carcinoma.—An average of 35 lymph nodes were examined, with a range of 25 to 42, in each of the specimens examined from 13 neck dissections for subglottic carcinoma. A clinically palpable node was present in only one patient, and this was demonstrated in the posterior triangle.

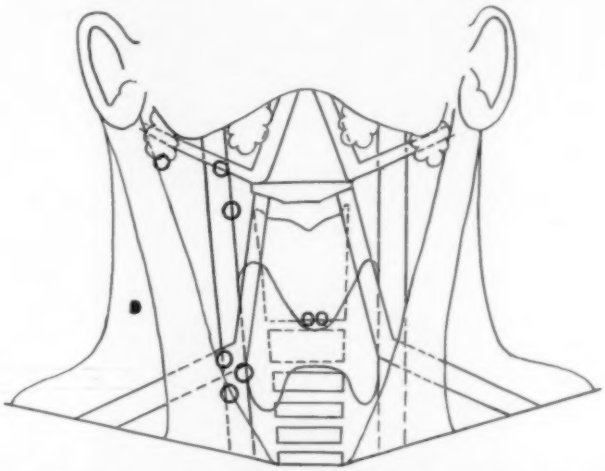


Fig. 23. Distribution of palpable and impalpable metastases in 13 subglottic cancers. ●—Palpable metastasis. O—Impalpable metastasis. Each circle represents the location of the involved node. Negative findings are not in the illustration.

In six of 12, *impalpable* metastases were demonstrated in lateral cervical nodes (50 per cent). Half of the impalpable metastases were located in the lower neck (see Fig. 23); three of six in the jugular-omohyoid area, one at the jugulo-digastric crossing, one opposite the pyriform sinus and one in the parotid area.

One positive impalpable node was found on the major side of the lone bilateral neck dissection specimen (local lesion crossed minor side by 10 mm.) Two impalpable metastases

involved the prelaryngeal node, one of which was associated with simultaneous microscopic metastases in the neck, and the other was associated with a small palpable node in the posterior triangle.

The average size of the two prelaryngeal nodes was 0.4 to 0.5 cm., while those in the deep neck measured an average of 0.8 cm. with a variation from 0.5 to 1.5 cm. (see Fig. 24).

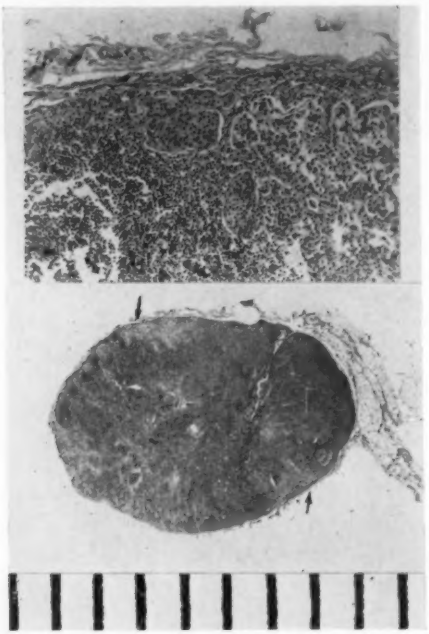


Fig. 24. The lower photomicrograph shows two foci of carcinoma in the sinusoids of a deep cervical node measuring 0.7 cm. Each line at the bottom represents 0.1 cm. The top illustration is a high power view.

In the group of six specimens without palpable nodes, two were found to have two coincident microscopically positive nodes in the deep jugular area. Carcinoma was not demonstrated in the submental nodes.

Nodal Metastases from Extrinsic Carcinoma.—An average of 38 lymph nodes was examined, with a variation of 20 to 58 nodes, in each of the specimens of unilateral neck dissection for extrinsic carcinoma. Up to 80 nodes were often found in the bilateral neck dissections. Three bilateral neck dissections were done, all on epiglottic carcinomas. Nodal metastases obtained from bilateral neck dissections were listed only *once* in the table, even if metastases were on both sides.

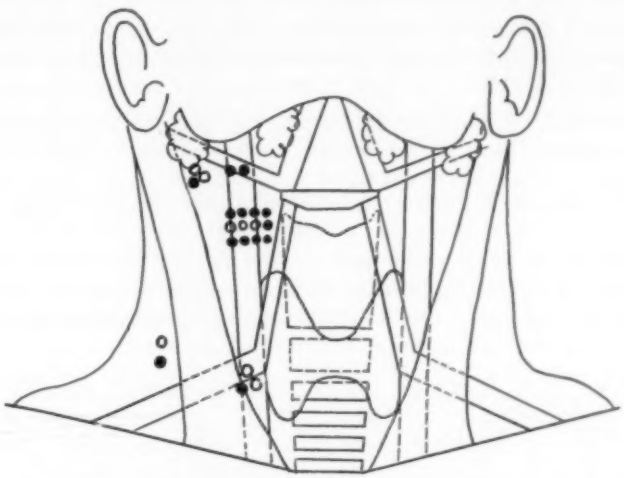


Fig. 25. Distribution of palpable and impalpable metastases in 28 extrinsic carcinomas. ●—Palpable metastasis. O—Impalpable metastasis. Each circle represents the location of the involved node. Negative findings are not in the illustration.

The first epiglottic carcinoma presented a small palpable node on one side and none on the other. One impalpable metastasis was demonstrated on the minor side. This was listed under clinically "negative" and miscroscopically "positive" in order to direct attention to the incidence of impalpable nodes. The remaining two were bilateral elective neck dissections. One of these showed carcinoma in impalpable nodes in both sides of the neck, and the other no metastases.

In 14 out of 28, clinically *palpable* nodes were present at the time of operation (see Fig. 25). The nodes varied in size.

The average was 3 cm. in the long axis and was larger than those found in the endolaryngeal carcinoma. In 13 of 14, while the main palpable node appeared to be movable and solitary, multiple nodal involvement immediately adjacent to the main mass was present.

A maximum of 11 positive nodes was found in the one side of the neck. In nine of 14, the commonest node involved was immediately adjacent to the pyriform sinus. Every triangle of the neck was involved except the submental area. Metastasis in a small high submaxillary node was found once as a small metastases in association with a larger one at the pyriform sinus area.

In eight of 14 extrinsic cancers (57 per cent), *impalpable* metastases were demonstrated in the lateral cervical lymphatics. These nodes averaged less than 1.0 cm. in length and were demonstrated just below the jugulo-digastric area in three of eight instances; in the parotid area twice; in the posterior triangle once, and in the jugular-omohyoid area twice. Multiple involvement of microscopically positive nodes was present in two cases. The prelaryngeal node was negative in every instance.

The great vessels in the neck are frequently invaded in extrinsic carcinoma of the larynx. The internal jugular vein and the carotid artery were each invaded with cancer twice, and in both instances the tumor thrombus was present in the vein.

Roentgen Therapy and Surgical Pathologic Observations.—Observations were made on eight irradiated specimens removed subsequent to heavy Roentgen therapy. In all instances, the decision for Roentgen therapy was made by another physician, and was referred for further treatment because of persistence of the primary lesion.

Pertinent information was obtained from the otolaryngologist and radiologist concerning the cervical nodes; the size of the field and amount of irradiation given was obtained from the roentgenologist. The cutaneous response noted after therapy was correlated with the size of the field of irradiation.

In one instance after treatment, a palpable node developed at the lower border of the field of irradiation and was confirmed in the specimen. In two other instances, impalpable metastases were found: one well outside of the field and one well within the field. In the latter, it was not possible to determine whether this node developed before, during or after Roentgen therapy. In three instances of positive nodes treated with X-ray, cancer was still present in the nodes.

In addition to the observations on the cervical nodes, there was noted in the primary lesion the usual irradiation response of fibrosis, thickening of vessels, varying degrees of focal necrosis and bizarre variations of the tumor cells. The changes seen in the cartilaginous structures of the larynx were insignificant, and necrosis of cartilages was absent.

CORRELATION OF NODAL OBSERVATIONS WITH THE LARYNGEAL LESION.

Location of Laryngeal Lesion and the Lateral Deep Cervical Nodes.—The *size* of the local laryngeal lesion was not related to the incidence, or to the appearance of the first evident metastasis. Given the same local characteristics of ulceration, fungation, degree of infiltration, and grade, a smaller lesion in an extrinsic area or subglottic area was as apt to metastasize as a larger one might not. The size and appearance of the laryngeal lesion with impalpable metastases, or clinically palpable nodes, was similar to lesions with negatives nodes.

The *grade* of the entire local lesion was of little help in predicting cervical metastases. There were just as many Grade III with or without microscopic or gross metastases as there were Grade II.

The primary tumor whose gross characteristics were ulceration and fungation was usually associated with deep infiltration. Those of the exophytic or papillary type only occasionally infiltrated the deeper tissue. There were 55 ulcerating, fungating and infiltrating types, but only four exophytic types. The incidence of cervical metastases was high in the former (37 of 55), while one of four exophytic types revealed a nodal metastasis. Frequently, examination of the deeper tissues of the larynx in those instances with nodal

metastases revealed perineural, lymphatic or vascular invasion by cancer.

The location of the primary lesion in the larynx was the most important factor in relation to the incidence and the area of cervical metastases. *Impalpable* metastases were demonstrated in the neck in eight of 14 extrinsic (57 per cent), in six of 12 subglottic (50 per cent), and in four of 13 endolaryngeal carcinomas (31 per cent). Ten out of 25 endolaryngeal and subglottic carcinomas revealed microscopic metastases in impalpable nodes (40 per cent). These nodal metastases were distributed widely, both in the upper and lower neck and were homolateral to the primary lesion.

TABLE II.

INVASION OF THYROID CARTILAGE AND PRE-EPIGLOTTIC SPACE AND CERVICAL METASTASES

Primary Lesion and Nodal Findings	Thyroid Cartilage		Pre-Epiglottic Space	
	Invaded	Not Invaded	Invaded	Not Invaded
ENDOLARYNGEAL				
Palpable-Positive*	3)	2)	3)	2)
	) 6	) 3	) 4	) 5
Impalpable-Positive*	3)	1)	1)	3)
Impalpable-Negative*	1	8	1	8
Totals	7	11	5	13
SUBGLOTTIC				
Palpable-Positive		1		1
Impalpable-Positive	1	5		6
Impalpable-Negative		6		6
Totals	1	12	0	13
EXTRINSIC				
Palpable-Positive	1 (lateral lamina)	13	3	11
Impalpable-Positive	1	7	6	2
Impalpable-Negative	1	5	4	2
Totals	3	25	13	15
ARYEPIGLOTTIC AND EPIGLOTTIC				
Palpable-Positive		3	3)	
			) 7	
Impalpable-Positive	1	3	4)	
Impalpable-Negative	1	4	4	1
Totals	2	10	11	1

* Negative and Positive denote demonstration or failure to demonstrate nodal metastases. See explanation under Classification: Definition of Clinically Palpable and Clinically Negative Nodes.

Crossed Nodal Metastases and the Location of the Primary Lesion.—In order to discuss the subject of crossed or contralateral metastases, clinical follow-up findings have been included. Over the past eight years, in patients observed from fifteen months to eight years, crossed metastases have not been observed following resection of endolaryngeal carcinoma, but have been found in two of 20 patients operated upon for unilateral extrinsic carcinomas, and one of 10 patients operated upon for unilateral subglottic carcinoma (10 per cent). For the entire group of 55 unilateral neck dissections, secondary neck dissection on the remaining side was not necessary in any endolaryngeal carcinoma but was necessary in one subglottic and in two extrinsic carcinomas of the larynx.

Invasion of the Thyroid Cartilage, Pre-Epiglottic Space and the Lateral Deep Cervical Nodes.—The nodal findings in the various primary laryngeal carcinomas are tabulated with relation to erosion of the thyroid cartilage and the invasion of the pre-epiglottic space (see Table II). It was observed in *endolaryngeal carcinoma* that in the presence of thyroid cartilage erosion, nodal carcinoma could be demonstrated more often than in the absence of cartilage destruction.

In six of seven (86 per cent), invasion of the anterior cartilage was associated with positive nodes in the lateral cervical area. In four of five (80 per cent), invasion of the pre-epiglottic space was associated with positive nodes. In four instances, invasion of both of these structures existed together in the same specimen. Nodal metastasis was found in the absence of invasion of the thyroid cartilage and pre-epiglottic space, but there were many negative nodal findings, eight of 11 (73 per cent), and eight of 13 (62 per cent), respectively.

The pre-epiglottic space was seldom invaded in subglottic and pyriform sinus cancers. In seven of 11 aryepiglottic fold and epiglottic carcinomas, tumor was demonstrated in the pre-epiglottic space and in the cervical nodes (64 per cent). In only one instance of epiglottic and aryepiglottic fold carcinoma, was there absence of preepiglottic space invasion and negative nodes.

Invasion of the thyroid cartilage occurred in characteristic fashion (see Figs. 26, 27). Initially, the tendon of the anterior

commissure was invaded followed by erosion of the thyroid cartilage. Carcinoma within the cartilage was found to spread in all directions, superiorly, inferiorly, laterally and anteriorly, until the external perichondrium was invaded. With further anterior extension through the external perichondrium, direct

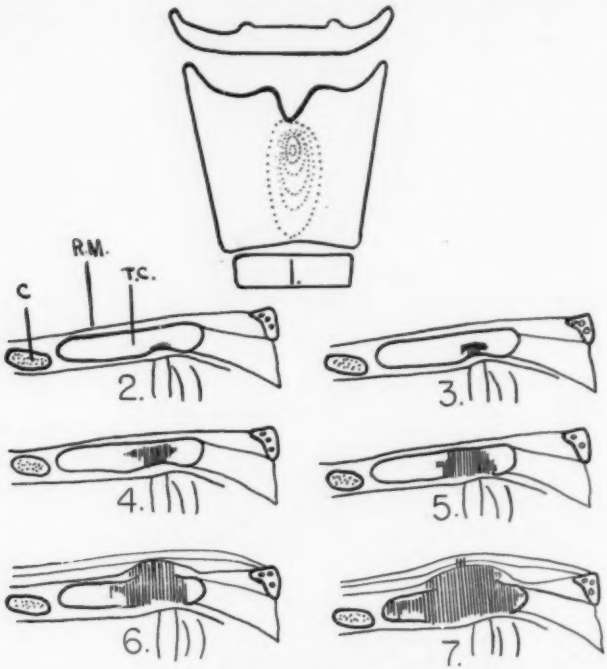


Fig. 26. Invasion of cancer into the anterior thyroid cartilage. 1. Anterior view of the thyroid cartilage; the dotted lines show the area of progressive destruction that may be demonstrated. 2-7. Sagittal views. 2-4. Various stages of increasing destruction of the thyroid cartilage. 5. Erosion into the external perichondrium of the thyroid cartilage. 6. Invasion into the ribbon muscles. TC — Thyroid Cartilage. RM — Ribbon muscles. C—Cricoid cartilage.

invasion of the strap muscles anterior to the larynx occurred. Erosion of the lateral thyroid ala was rarely observed in extrinsic carcinoma. In subglottic and extrinsic carcinomas invasion of the anterior thyroid cartilage was infrequent (three of 41), and could not be correlated with nodal metas-

tases. In one endolaryngeal carcinoma, invasion of the anterior thyroid cartilage was associated with an impalpable metastasis of the prelaryngeal node.

Endolaryngeal and epiglottic carcinomas invaded the pre-epiglottic space readily through its apex or through the fenestrations of the epiglottic cartilage (see Figs. 28, 20). Aryepiglottic fold cancers frequently invaded the lateral portion of the pre-epiglottic space.

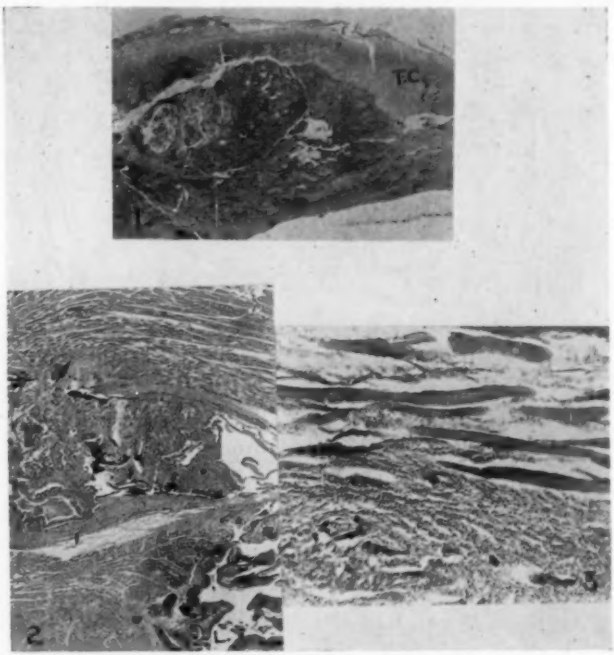


Fig. 27. Invasion of the anterior thyroid cartilage. 1. Note the destruction of cartilage by a large neoplastic mass; TC—Thyroid cartilage. 2. Cancer has extended anteriorly into the ribbon muscles in the area indicated by arrow; note the pieces of degenerating cartilage. 3. High power view of ribbon muscles in the area of the arrow.

The thyroepiglottic ligament and membrane is composed of thin connective tissue and elastic fibers, extending from the petiole of the epiglottis to the inner and anterior perichon-

drial surface of the thyroid in the region of the anterior commissure of the true cords.

This membrane is quite thin and does not resist tumor invasion into this loose areolar tissue which contains lymphatic channels. Whereas the median and lateral hyothyroid mem-

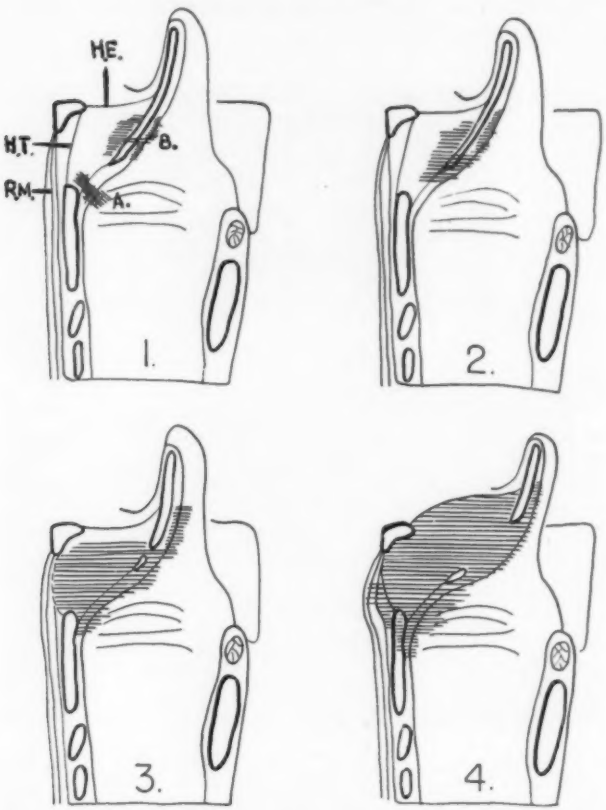


Fig. 28. Invasion of the pre-epiglottic space. 1. The area of (A) indicated by cross-hatching shows the common point of invasion into the pre-epiglottic space in endolaryngeal carcinoma. The area (B) is the common site for epiglottic cancer. 2. Invasion through the fenestrations of the cartilage. 3. Extension of cancer to the anterior thyro-hyoid membrane (H.T.). 4. Superior extension pushes the hyo-epiglottic membrane (H.E.) upwards, and may invade the base of the tongue; note invasion of the ribbon muscles (R.M.).

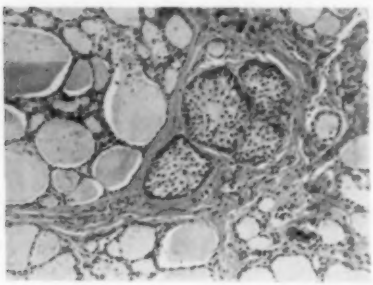


Fig. 29. Tumor within vascular channels of the thyroid gland.

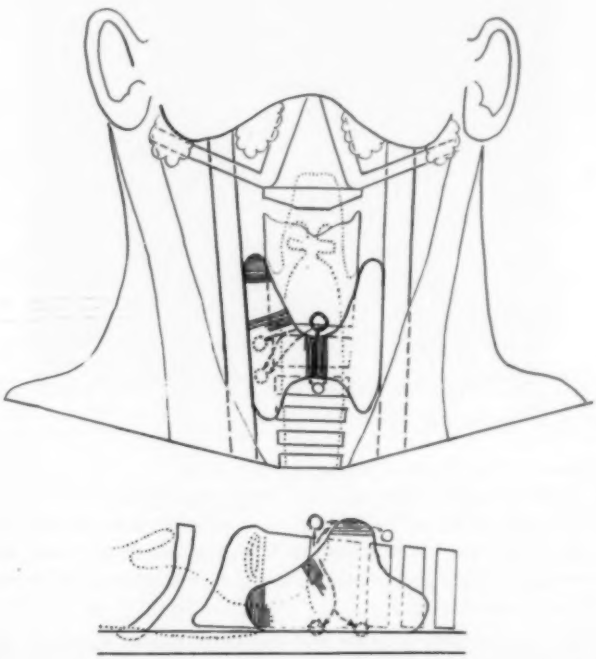


Fig. 30. Thyroid gland relationship with the larynx; the upper and lower schematic drawings show the areas of the thyroid gland invaded by cancer. Note the intimate relationship of the superior lobe with the pyriform sinus and the isthmus, and lateral lobe with the cricothyroid membrane; the dotted arrows show the direction of possible lymphatic extension. ●—Prelaryngeal note; ◔—Paratracheal node; ○—Pretracheal node.

brane and hyoepiglottic ligament and membrane tend to confine the tumor within this space, the pre-epiglottic space neoplasm can spread in the lateral portions of this space along the outlet of the superior laryngeal vessels into the neck. In pyriform sinus and subglottic carcinomas, involvement of the pre-epiglottic space was unusual (two of 27), and could not be correlated with nodal metastases.

Prelaryngeal Nodes and the Lateral Deep Cervical Nodes.— In three endolaryngeal carcinomas and two subglottic carcinomas, the prelaryngeal node was microscopically positive. In all five instances where the prelaryngeal node was involved,

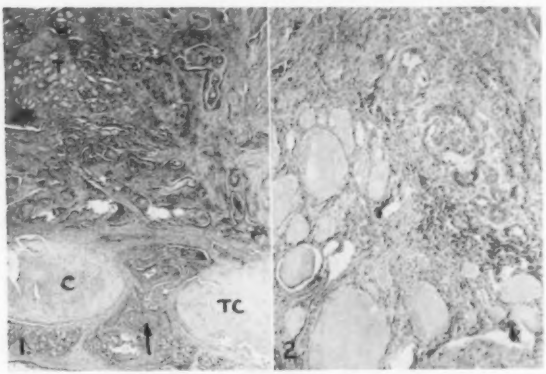


Fig. 31. Invasion of the thyroid gland and ribbon muscles. 1. The arrow indicates the direction of invasion through the cricothyroid area into the anterior neck. 2. High power of area T. T—Thyroid gland. C—Cricoid cartilage. TC—Thyroid cartilage.

carcinoma was demonstrated in the deep cervical lymphatics (see Figs. 21, 23). Two of the five were associated with small clinically palpable nodes in the cervical lymphatics, and three were associated with microscopically positive impalpable nodes in the neck. The prelaryngeal node was negative in extrinsic cancers of the larynx.

Other associated lesions with positive prelaryngeal nodes were one instance of thyroid cartilage invasion in endolaryngeal carcinoma, one instance of invasion of the sternohyoid muscle in subglottic carcinoma, and one instance of a metastasis in a paratracheal node.

The Thyroid Gland, Prelaryngeal and Paratracheal Nodes and Sternohyoid and Sternothyroid Muscles.—In two instances of *endolaryngeal* carcinoma the thyroid isthmus contained lymphatic carcinomatous emboli (see Fig. 29). In one of the two with invasion of the thyroid, an impalpable metastasis of the prelaryngeal node was also present, but not in the other.

In two subglottic carcinomas, tumor infiltrated the isthmus in one, and the capsule of the tracheal surface of the lateral lobe of the thyroid in the other (see Figs. 10, 30, 31). In one of two with invasion of the thyroid, tumor was shown to infiltrate the sternohyoid and sternothyroid muscles.

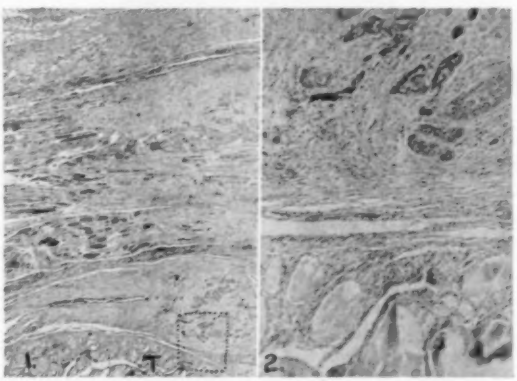


Fig. 32. Invasion of the superior lobe of the thyroid gland. 1. Low power showing cancer immediately adjacent to the thyroid. 2. High power view of dotted area. T—Thyroid.

The paratracheal nodes that are normally located posteriorly and medially and in close proximity to the lateral lobe of the thyroid gland were involved in two instances of endolaryngeal carcinoma. In one of the above two, a positive prelaryngeal node was also present.

The capsule of the superior lateral lobe of the thyroid was invaded twice by tumor in extrinsic cancer (see Fig. 32). The isthmus of the thyroid was not invaded in extrinsic carcinoma.

The sternohyoid and sternothyroid muscles, often referred

to as the ribbon or strap muscles, were invaded in five of 59 specimens. In one instance of endolaryngeal carcinoma these muscles were invaded at the point of tumor penetration through the external perichondrium of the anterior thyroid cartilage. In subglottic carcinoma invasion of the ribbon muscles and thyroid gland was found in one case, and invasion of the ribbon muscles and the prelaryngeal node, in another (see Fig. 33). In two epiglottic carcinomas the tumor passed through the anterior hyoepiglottic ligament to invade the ribbon muscles.

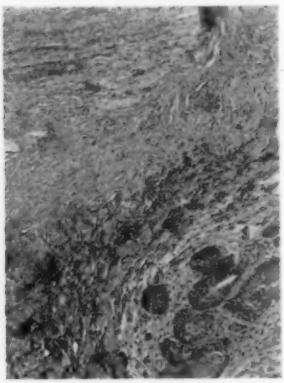


Fig. 33. A focus of cancer in the ribbon muscles was accidentally found adjacent to the prelaryngeal node.

DISCUSSION.

The results of this study of surgical pathology of cancer of the larynx indicate that a relationship exists between the primary lesion and the likelihood of occult metastatic disease. Some information has also been obtained with respect to the incidence of metastatic disease in sites not always appreciated. The degree of correlation between the extent of the local disease and the metastatic disease may be altered by expansion of the series of specimens studied. There is substantial agreement between comparable findings in the author's series and observations reported in the literature.

Pathologic investigation of carcinoma of the larynx in the present group revealed a high incidence of widespread metastases in impalpable nodes* homolateral to the primary lesion in the extrinsic, the subglottic or the endolaryngeal areas. Such wide scattering of nodes would explain lateral neck "recurrences" after laryngectomy. When such nodes become clinically evident following laryngeal surgery, the low position and size of such nodes often increase the likelihood of failure of secondary neck dissections.

After irradiation of the neck, wide scattering of positive impalpable nodes would explain "recurrences" at the border, or outside of the irradiated field. In two patients who had previously received radiotherapy, the surgical findings supported this suggestion. It becomes much more difficult, if not impossible, as impalpable nodes increase the size of the field, for radiotherapy to sterilize the tumor adequately.

The high incidence of impalpable nodes has been related to surgical failure by several authors,[7,21,28,72,73,76,78,89] whose evidence indicates that demonstrably invaded impalpable nodes may explain the great majority of failures of simple laryngectomy. In the writer's experience, metastases in impalpable nodes in four of 13 (31 per cent) specimens of endolaryngeal carcinoma were not surprising, if one appreciates that the lymphatic supply is rich immediately above the cord. Carcinoma rarely metastasizes from a mobile true cord, but in fixation of the cord due to invasion of muscle, infiltration into the muscular lymphatics may lead to lateral cervical nodal metastases.

Pietrantoni, et al.,[78] reported a high incidence of metastases from vestibular carcinoma in impalpable nodes, but they gave no exact figures. In their classification, vestibular carcinoma may include those involving the arytenoid. Since the incidence of metastasis is unusually high when the arytenoid is involved, from their data it is difficult to determine the exact incidence of metastatic carcinoma from the false cord and the ventricular areas. The demonstration of positive impalpable nodes in one-half of the number of sub-

* The discussion of impalpable nodal metastases is restricted to instances in which clinical examination of the neck was negative for nodes as described under Classification.

glottic and extrinsic carcinomas in the writer's series correlates well with the figures of 46 per cent and 58 per cent respectively reported by Pietrantoni, et al.[78]

Pietrantoni and his collaborators,[78] and Bocca[7] have related the high incidence of cancer in impalpable nodes demonstrated after elective neck dissection to eventual surgical success. Pietrantoni's group[78] reported a 63 per cent five year survival for patients treated by prophylactic or elective neck dissections with laryngectomy for vestibular carcinoma and 25 per cent for laryngectomy alone.

Bocca, who is a colleague of Pietrantoni, similarly reports 65 per cent five year survival for patients whose vestibular cancer was treated by prophylactic neck dissection with laryngectomy, and 25 per cent by therapeutic neck dissection. The clinical reports by Sylvester-Begnis[89] and Del Sel[28] also suggest that better results are to be expected with one-stage radical surgery than by withholding neck dissection until nodes have been demonstrated, or by irradiation of nodes that are already palpable.

There was a high degree of correlation between positive prelaryngeal nodes and lateral cervical metastases from *subglottic* and *endolaryngeal tumors* in the author's series, (five of five). Rouviere's[80] study of the lymphatics of the larynx and neck would lead one to anticipate progressive spread from the endolaryngeal area to the prelaryngeal node, and then to the deep cervical area; however, since the prelaryngeal metastases were microscopic or small, and those in the lateral cervical lymphatics were equally small or larger and widely dispersed, they may have occurred as essentially multiple lymphatic emboli.

It is important to determine whether this high degree of correlation between positive prelaryngeal nodes and deep cervical nodes will be found in a larger series of observations. It is of interest to note that prelaryngeal nodal metastasis has not been found with *extrinsic carcinoma* of the larynx, although deep cervical metastases are common. Apparently, lymphatic spread from sites superior to the true cord does not involve the inferiorly directed lymphatic channels which are efferent from the true cord.

The observation that impalpable metastases were predominantly homolateral to the primary lesion correlates well with the infrequency of contralateral or crossed nodal metastases noted. The incidence of crossed nodal metastasis in the present group was low, (none for endolaryngeal, one of 10 for subglottic and two of 20 for extrinsic cancer) too low to justify bilateral elective neck dissection with laryngectomy for unilateral carcinoma.

Palpable adenopathy has become generally accepted as an absolute indication for radical neck dissection with laryngectomy for all types of advanced laryngeal carcinoma.[7,13,21,28,72,73,76,89] Multiple impalpable nodes have almost invariably been found in association with palpable nodes, while direct extension from larger nodal metastases may involve the great vessels of the neck. A palpable metastasis, therefore, may determine the prognosis rather than the primary site and local extension of the lesion.

An important relationship exists between *endolaryngeal* lesions and the likelihood of involvement of the cartilages of the larynx and the pre-epiglottic space. With invasion of these structures nodal metastases are frequent, while in the absence of this invasion nodal metastases are much less likely. In the writer's series of endolaryngeal carcinoma, in six of seven (86 per cent), invasion of the thyroid cartilage was associated with positive lateral cervical findings.

Similarly in four of five (80 per cent), involvement of the pre-epiglottic space was associated with positive lateral cervical findings. By contrast, in the absence of invasion of the thyroid cartilage, positive cervical nodes were found in three of 11 specimens (27 per cent), and in the absence of invasion of the pre-epiglottic space, positive nodes were found in five of 14 specimens (38 per cent).

Broyles[12] attributes the frequency of invasion of the anterior thyroid cartilage to the intimate relationship between the cartilage and the tendon of the anterior commissure. Absence of this intimate relationship lateral to this tendon may explain why direct extension of cancer through the lateral lamina of the thyroid cartilage has not been observed.

The tendon of the anterior commissure is a band of fibrous tissue, measuring about one mm. in width and 10 mm. in length, located in the midline on the posterior aspect of the anterior thyroid cartilage, whose lymphatics and blood vessels enter the perichondrium of the thyroid cartilage.

The correlation noted between nodal metastases and invasion of cancer into the thyroid cartilage and pre-epiglottic space in *endolaryngeal* carcinoma was not found in *subglottic* and certain *extrinsic* cancers. An explanation may be based upon anatomical considerations. In subglottic carcinoma, the tumor arises laterally beneath the true cord and reaches the anterior commissure tendon area relatively late in its evolution. In pyriform sinus carcinoma, extension occurs around the lateral lamina long before approaching the anterior thyroid cartilage.

The pre-epiglottic space is in intimate anatomic relationship with epiglottic, aryepiglottic and endolaryngeal cancers, whereas this space is distantly related to pyriform sinus and subglottic cancers. Invasion of the pre-epiglottic space occurs relatively early from the first three sites and may occur relatively late in the latter two areas.

In spite of the readily adduced explanations from anatomical considerations for extension of laryngeal cancer to the thyroid cartilage and the pre-epiglottic space, it is important to determine whether these relationships will be borne out by a larger experience because of the prognostic significance of such extensions.

The thyroid gland and the ribbon muscles are in close relationship to the thyroid and cricoid cartilages and the pre-epiglottic space, and may become involved with or without invasion of the thyroid cartilage, the pre-epiglottic space or the prelaryngeal node. These observations may explain many surgical failures, expecially those of narrow field procedures.

Since involvement of the thyroid gland was demonstrated in about 10 per cent of the writer's series, neck dissection should include *en bloc* removal of the lateral lobe and isthmus. In four instances, the thyroid capsule was invaded by direct extension, and in two instances lymphatic tumor emboli were

found on microscopic examination. In addition, the paratracheal nodes, demonstrably involved in two instances, were readily removed only in conjunction with the adjacent thyroid gland.

Invasion of the sternohyoid and sternothyroid muscles has also been demonstrated through the anterior thyroid cartilage in endolaryngeal carcinoma (once), through the cricothyroid membrane in subglottic carcinoma (twice) and through the hyo-epiglottic ligament in epiglottic carcinoma (twice).

The results discussed above provide some explanation for the shortcomings of limited surgical procedures in cancer of the larynx. Evidence has been presented which indicates that more extensive radical surgery should materially improve the outlook for cancer of the larynx.

SUMMARY.

1. A pathologic study of 59 surgical specimens removed from laryngectomy and elective or therapeutic radical neck dissections for carcinoma of the larynx has been presented.

2. Fifty-five tumors (93 per cent) were characterized by ulceration, fungation and deep infiltration; three were exophytic, papillary structures and infiltration was minimal. Fifty-six tumors (95 per cent) were of the squamous cell variety and three were adenocarcinomas.

3. Observations of characteristic features of the local disease were presented according to the classification of endolaryngeal, subglottic and extrinsic carcinoma.

In 18 endolaryngeal carcinomas, the following features were noted:

1. The tumor of the true cord was localized to its anterior half for some time, and slowly invaded the false cord and ventricle, anteriorly and superiorly.
2. Fixation of the cord was due to infiltration by cancer of the intrinsic muscles, and was not due to invasion of the arytenoid cartilage.
3. Carcinoma as lymphatic emboli was occasionally observed in the deep local tissue.

4. Invasion of the anterior thyroid cartilage was commonly demonstrated (seven of 18). Primary invasion of the lateral lamina of the thyroid and the cricoid cartilages was not observed.

5. Infiltration of the pre-epiglottic space was observed in five instances. Frequently, invasion of this space and of the thyroid cartilage was found in the same specimen (four of 18).

6. Involvement of the immediate extralaryngeal soft tissue structures is frequent.

   a. Occult metastases to the prelaryngeal node were infrequently demonstrated (twice).

   b. Invasion of the thyroid gland occurred twice, and in two instances positive paratracheal nodes were in close apposition to the gland.

   c. Infiltration of the sternohyoid and sternothyroid muscles was found once.

In 13 subglottic carcinomas the following features were noted:

1. The tumor remained localized beneath the true cord and was frequently unilateral. The center or origin was 0.6 to 1.0 cm. beneath the cord, often the advancing margins of the tumor were submucosal; infiltration of the supraglottic area was infrequent.

2. Invasion through the cricothyroid membrane was observed (three of 13).

3. Fixation of the vocal cord was due to tumor infiltration of the intrinsic muscles and not to invasion of the arytenoid cartilage.

4. Lymphatic and perineural lymphatic invasion was frequently observed in the deeper subglottic tissues.

5. Destruction of the anterior thyroid cartilage was unusual (once), and erosion of its lateral lamina was not demonstrated. The cricoid cartilage was seldom invaded by cancer (once).

6. Invasion of the pre-epiglottic space was not demonstrated.

7. Involvement of immediate extralaryngeal soft tissue structures was frequent.

   a. Occult metastases to the prelaryngeal node was not infrequently found (three of 13).

   b. Invasion of the thyroid gland was observed twice.

   c. Infiltration of the sternohyoid and sternothyroid muscle was observed twice.

In 28 extrinsic carcinomas, the following features were noted:

1. The primary tumor rapidly and deeply infiltrated the local area and spread laterally toward the lateral cervical lymphatics.

2. Invasion of the endolarynx occurred frequently by the direct "retrograde" submucosal route, but subglottic invasion was rare.

3. Fixation of the cord, if present, was due to tumor about the perichondrium of the arytenoid cartilage and secondary invasion of the intrinsic muscles. Twice, the arytenoid cartilage was directly infiltrated.

4. Submucosal and deep lymphatic tumor invasion was invariably demonstrated in the local lesion.

5. Involvement of the pre-epiglottic space occurred very frequently with aryepiglottic fold and epiglottic cancers (11 of 12) and infrequently with pyriform sinus cancers (two of 16).

6. Invasion of the anterior thyroid cartilage was not observed, and only once was its lateral lamina invaded.

7. Involvement of immediate extralaryngeal soft tissue structure is frequent.

   a. Metastases were never demonstrated in the prelaryngeal node.

   b. The superior lobe of the thyroid was invaded twice.

c. Twice in epiglottic carcinoma, there was infiltration of the sternohyoid and sternothyroid muscles. This was not found in other extrinsic cancers.

4. The tumors were grouped according to presence or absence of palpable nodes. The following characteristics were noted for the impalpable group:

1. Impalpable nodes which contained carcinoma were homolaterally demonstrated in four of 13 endolaryngeal carcinomas (31 per cent), in six of 12 subglottic carcinomas (50 per cent), and eight of 14 extrinsic carcinomas (57 per cent).

2. In all three primary lesions, carcinoma in impalpable nodes was demonstrated in all triangles in the neck, except in the submental area. These nodes were equally distributed, and widely dispersed in the lateral neck.

3. Such positive impalpable nodes often measured 0.5 to 1.3 cm. in their longest axes.

The characteristics of the palpable node group are:

1. Palpable nodal metastases were demonstrated in five of 18 endolaryngeal cancers, one of 13 subglottic cancers and 14 of 28 extrinsic cancers.

2. Multiple positive nodes were invariably demonstrated in association with the main palpable node.

5. Crossed metastases have not been found in any of the endolaryngeal carcinomas but were found in one of 10 unilateral subglottic carcinomas, and in two of 20 unilateral extrinsic carcinomas (10 per cent).

6. Correlation between the invasion of cancer into the immediate extralaryngeal structures, the prelaryngeal node, the thyroid cartilage, the pre-epiglottic space and lateral cervical nodal metastases revealed the following:

1. In every instance of endolaryngeal and subglottic carcinoma, when the prelaryngeal node was microscopically positive, cancer was demonstrated in the lateral deep cervical nodes (five of five).

2. In endolaryngeal carcinoma, invasion of the thyroid cartilage and of the pre-epiglottic space was usually associated with demonstrable cancer in the deep cervical lymphatics (six of seven or 86 per cent, and four of five or 80 per cent respectively). In the absence of invasion, there was a lower incidence of positive nodes (three of 11 without cartilage invasion and five of 13 in the absence of pre-epiglottic space invasion), with a corresponding higher incidence of negative nodal findings. In subglottic and extrinsic cancers, invasion of the thyroid cartilage was rarely observed.

3. In epiglottic and aryepiglottic fold carcinoma, involvement of the pre-epiglottic space was invariable (11 of 12), and was associated with a significant incidence of positive nodes (seven of 11) in the lateral neck. Absence of invasion of the pre-epiglottic space was rare (one of 12), and in this instance positive nodes were not found.

7. The following observations on the thyroid gland and the ribbon muscles were noted:

1. Invasion of the thyroid gland was encountered in six of the 59 specimens (10 per cent). Carcinoma has been demonstrated in the isthmus, lateral lobe, and superior lobe, either as lymphatic emboli within the gland or as invasion of its capsule. Positive paratracheal nodes have been found in immediate apposition to the capsule of the gland.

2. Invasion of the sternohyoid and sternothyroid muscles was demonstrated in five of 59 laryngeal cancers and can occur through the anterior hyoepiglottic ligament, through an eroded thyroid cartilage, or through the cricothyroid membrane.

3. Invasion of cancer in these structures, the thyroid gland and the ribbon muscles, has been occasionally demonstrated independent of involvement of the thyroid cartilage, the pre-epiglottic space and the prelaryngeal node.

CONCLUSIONS.

1. A study of the three primary types of laryngeal carcinoma revealed characteristic differences of local spread and invasion. The location of the primary tumor was the determining factor as to frequency of invasion of the prelaryngeal node, the pre-epiglottic space, and the thyroid cartilage.

2. Differences existed between the site of origin and the incidence of impalpable metastases. A high incidence of metastases was demonstrated in impalpable nodes from extrinsic, subglottic and endolaryngeal carcinomas (57 per cent, 50 per cent and 31 per cent respectively). Impalpable metastases observed in the lateral deep cervical nodes were nearly always homolateral and rarely contralateral to the primary lesion; therefore, initial accurate clinical classification of the primary lesion is extremely important.

3. In endolaryngeal and subglottic carcinoma, there was a high degree of correlation between involvement of the prelaryngeal and deep cervical nodes.

4. In endolaryngeal carcinoma, there was good correlation between invasion of the thyroid cartilage and pre-epiglottic space and cancer in the cervical nodes. Absence of invasion of these structures does not rule out the possibility of invasion of lateral cervical lymphatics.

5. In epiglottic and aryepiglottic fold cancer, invasion of the pre-epiglottic space almost invariably occurred and was associated with a high incidence of carcinoma in the cervical nodes.

6. In endolaryngeal, subglottic, epiglottic and aryepiglottic fold cancers, the demonstration of tumor invasion in the prelaryngeal nodes, in the thyroid cartilage, or in the pre-epiglottic space are important prognostic findings.

7. Involvement of the thyroid gland and of the sternohyoid and sternothyroid muscles occurred often enough to be considered a likely metastatic feature of cancer of the larynx.

8. The results of this study on specimens removed from laryngectomy and neck dissection on a consecutive group of

operable laryngeal carcinomas, which support the above conclusions, seem to warrant the following surgical considerations:

a. Only wide field laryngectomy will encompass the local laryngeal lesion. This surgery should include not only the hyoid bone, the first tracheal ring, all ribbon muscles from the hyoid to the sternum, and tissue lateral to the anterior border of the sternocleidomastoid muscle, but should also include the isthmus and lateral lobe of the thyroid on the side of the lesion. The infrequency of invasion of the thyroid gland or the ribbon muscles does not constitute a reason for preserving these structures.

b. Therapeutic neck dissection with laryngectomy is mandatory, but often multiple nodal involvement is demonstrated, and these nodes may determine the prognosis rather than the primary lesion.

c. The incidence of impalpable metastases from endolaryngeal, subglottic and extrinsic cancers is sufficiently high to justify *en bloc* elective unilateral or bilateral neck dissection with laryngectomy.

d. Secondary neck dissection must be strongly considered in a specific situation. If pathologic examination of the specimen from simple laryngectomy reveals metastasis in a prelaryngeal node invasion of the thyroid cartilage or the pre-epiglottic space, there is likelihood of further spread to the lateral neck.

e. Because of the low incidence of crossed nodal metastasis, bilateral elective neck dissection appears to be contraindicated in every instance of unilateral carcinoma of the larynx.

BIBLIOGRAPHY.

1. Ackerman, L. and Del Regato, J.: Cancer, Diagnosis, Treatment and Prognosis. C. V. Mosby, St. Louis, 1947.

2. Ackerman, L.: Surgical Pathology. C. V. Mosby, 1953.

3. Ballenger, W. H. and Ballenger, H. C.: Diseases of the Nose, Throat and Ear. Lea and Febiger, 1943, page 512.

4. Bisi, R. H.: La Laryngectomia con Extirpacion Expacia Pre-Epiglottico. Second Congress Sud. Amer. de Otorrinolaringo. Asuartado Toneo 111:1920, 9:235, 1944. Ibid: Dia Med. 15:1263-1264, Nov. 15, 1943.

5. Blady, J. V.: Treatment of Cancer of the Larynx. *Amer. Jour. Roentgenol.*, 58:331-341, 1947.

6. Blair, V. P.: Radical Operation for Extrinsic Cancer of the Larynx. *Ann. Otol., Rhinol. and Laryngol.*, 33:373-389, 1923.

7. Bocca, Ettore: Functional Problems Connected with Bilateral Neck Dissection. *Jour. Laryngol. and Otol.*, 67:567-577, Sept., 1953.

8. Boies, L. R.: Fundamentals of Otolaryngology. W. B. Saunders, 1954, page 435.

9. Brachetti-Brian, D. and Samengo, L. A.: Las Adenopatias Metastasicas Cervicales no Palpables en 11 Cancer de la Laringis Confirmados por el Vaciamento Profilactico. *La Prensa Medica Argentina*, 37:3033-3034, Dec., 1950.

10. Broders, A. C.: Squamous Cell Carcinoma of the Lip. *J.A.M.A.*, 74:656-664, March, 1920.

11. Browne, Lennox: Diseases of the Throat. Lea Bros., Phila., 1893, chap. 22.

12. Broyles, E.: The Anterior Commissure Tendon. *Ann. Otol., Rhinol., and Laryngol.*, 52:342-345, 1943.

13. Brunschwig, A.: Panlaryngectomy for Advanced Carcinoma of the Larynx. *S. G. O.*, 76:390-394, April, 1943.

14. Caliceti, P.: Evidement of Cervical Lymph Nodes in Cancer of the Larynx. *Otorinolaringo Ital.*, 9:105-130, March, 1939.

15. Caliceti, P.: Studio Anatomo-Istogico ed istogetico dei Tumori Maligni della Laringe. *Oto-Rino-Laryngologia Italiano*, 10:177-185, May, 1940.

16. Chappel, W. F.: Early Diagnosis of the Malignant Diseases of the Larynx; Pathology, Prognosis and Treatment. *Trans Amer. Laryngol., Rhinol., and Otol. Soc.*, 15:39-53, 1909.

17. Chiari, O.: The Treatment of Cancer of the Larynx. *Trans. Amer. Laryng., Rhinol., and Otol. Soc.*, 1-38, 1909.

18. Clerf, L.: Cancer of the Larynx; Analysis of 250 Operated Cases. *Arch. Otol.*, 32:484-498, 1940.

19. Clerf, L.: Pre-Epiglottic Space; Its Relation to Carcinoma of the Epiglottis. *Arch. Otol.*, 40:177-179, 1944.

20. Clerf, L.: Symposium on Carcinoma of the Larynx; Summary and Discussion. *Trans. Amer. Acad. Ophthal. and Otol.*, 38-54, Jan.-Feb., 1954.

21. Clerf, L., Putney, F. J., and O'Keefe, J. J.: Carcinoma of the Larynx. The Laryngoscope, 58:632-641, July, 1948.

22. Colledge, L. and Peacock, R.: Analysis of 126 Cases of Malignant Diseases of the Upper Air Passages Treated from 1921-1930. *Jour. Laryngol. and Otol.*, 47:161-187, 1932.

23. Colledge, L.: Pathology and Surgery of Cancer of the Larynx. *Trans. Med. Soc.*, London, 63:306-333, 1945.

24. Coutard, H.: Present Conception of Treatment of Cancer of the Larynx. *Radiology*, 34:136, 1940.

25. Crile, G.: Excision of Neck Cancer. *J.A.M.A.*, 47:1780-1788, 1906.

26. Del Regato, J. A.: Roentgen Therapy of Carcinoma of the Endolarynx. The Laryngoscope, 61:511-516, 1951.

27. Del Regato, J. A.: Present Day Status of Radiotherapy of Cancer of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, Jan.-Feb. 35-37, 1954.

28. Del Sel, J. and Agra, A.: Cancer of the Larynx; Laryngectomy with Systematic Extirpation of the Connective Tissue and Cervical Lymph Nodes as a Routine Procedure. *Trans Amer. Acad. Ophthal. and Otol.*, 653-655, July-Aug., 1947.

29. Eggston, A. A. and Wolff, D.: Histopathology of the Ear, Nose and Throat. Williams and Wilkins Co., 1947, page 1015.

30. Figi, F. A.: Hemilaryngectomy with Immediate Skin Graft for Removal of Carcinoma of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, Jan.-Feb., 1954, 22-25.

31. Foulis, D. F.: Extirpation of the Larynx. *Lancet*, 2:530, 1877; 1:118, 1878; 1:436, 1879; *Internat. Med. Cong., London*, Sect. on Laryng., 3:222, 1881.

32. Fraser, J. S. and Warson, D.: Notes on Fourteen Cases of Intrinsic Cancer of the Larynx with Demonstration of Pathologic Anatomy. *Jour. Laryngol. and Otol.*, 39:79-89, 1924.

33. Furstenberg, A. C.: Introduction, Diagnosis and Differential Diagnosis of Cancer of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, Jan.-Feb., 1954, 7-12.

34. Garland, L. H.: X-ray Therapy; Symposium on Carcinoma of the Larynx. The Laryngoscope, 62:75-89, 1952.

35. Graham, Harrington, B.: The Pathology of Cancer of the Larynx. *Ann. Otol., Rhinol., and Laryngol.*, 41:453-459, 1932.

36. Greene, D. C.: The Lymphatic Drainage of the Larynx. *Trans. Amer. Laryngol. Assoc.*, 63-69, 1906.

37. Harris, W. and Klemperer, P.: Pathologic Differentiation Between Radiosensitive and Non-sensitive Malignant Neoplasms Treated by Coutard's Method. *Arch. Otol.*, 28:355-363, Sept., 1938.

38. Hassin, G. B.: Carcinoma in Muscle Tissue as a Cause for Vocal Cord Paralysis. *Jour. Neuropath. and Exp. Neurol.*, 6:358-368, Oct., 1947.

39. Hautant, A.: Cancer Endolarynge, Monographie. Masson et Cie, Paris, 1930.

40. Jackson, C.: Primary Malignancy Disease of the Larynx. The Laryngoscope, Aug., 1904. Ibid: Primary Carcinoma of Nasopharynx; Table of Cases., *J.A.M.A.*, 37:371-377. (Discussion, page 380), Aug. 10, 1901.

41. Jackson, C.: Peroral Endoscopy and Laryngeal Surgery. The Laryngoscope Co., St. Louis, 1915.

42. Jackson, C. and Jackson, C. L.: Cancer of the Larynx. W. B. Saunders, Phila., 1939, page 35.

43. Jackson, C. and Jackson, C. L.: Diseases of the Nose, Throat and Ear. W. B. Saunders, page 559, 1945.

44. JACKSON, C.: Laryngo-Fissure. *Trans. Amer. Acad. Ophthal. and Otol.*, 58:16-21, Jan.-Feb., 1954.

45. JACOBSSON, F.: Carcinoma of the Hypopharynx. *Acta Radiol.*, 35:1-21, Jan., 1951.

46. KERNAN, J. D.: Fundamental Pathology of the Larynx. THE LARYNGOSCOPE, 47:77-91, Feb., 1937.

47. KERNAN, J. D.: Surgical Aspects of Carcinoma of the Larynx. THE LARYNGOSCOPE, 52:353-361, May, 1942.

48. KERNAN, J. D.: The Pathology of Carcinoma of the Larynx, Studied in Serial Section. *Trans. Amer. Acad. Ophthal. and Otol.*, 10-21, 1950-1951.

49. KRISHABER: Gaz Hebd. de Med et de Chirurg., 1879, IVI, 33, 518.

50. KYLE, D. B.: Textbook of the Diseases of the Nose and Throat. W. B. Saunders, Phila. and London, page 275, 1915.

51. LEDERER, F. L. and HOLLANDER, A. R.: Textbook of the Ear, Nose and Throat. F. A. Davis Co., page 516, 1951

52. LEJEUNE, F. E. and BAYON, P. J.: Carcinoma of the Larynx. *Ann. Otol., Rhinol., and Laryngol.*, 51:460-470, 1942.

53. LEJEUNE, F. E.: Surgical Treatment of Early Carcinoma of the Larynx. THE LARYNGOSCOPE, 61:488-495, June, 1951.

54. LEJEUNE, F. E.: Transoral Surgery for Early Carcinoma of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, Jan.-Feb., 13-21

55. LENZ, M.: Roentgen Therapy in Cancer of the Larynx. *J.A.M.A.*, 134:117-121, May 10, 1947.

56. LEROUX-ROBERT, J.: Anatomo-Clinical Types and Therapeutic Indications Regarding Intralaryngeal Epithelioma. *Annals d'Otol.*, 1003-1044, 1937.

57. LEWIS, R. S.: Management of Cervical Metastasis from Laryngeal Carcinoma. *Proc. Roy. Soc. Med.*, 46:481-490, July, 1953.

58. MCKENTY, JOHN E.: Surgical Treatment of Laryngeal Cancer, *N. Y. State Jour. of Med.*, 22:456-462, Oct., 1922.

59. MCKENTY, JOHN E.: Carcinoma of the Larynx. *Arch. Otol.*, 3:205-252, 305-337, 1926.

60. MCKENZIE, JOHN N.: A Plea for Early Naked-Eye Diagnosis and Removal of the Entire Organ with the Neighboring Area of Possible Lymphatic Infection in Cancer of the Larynx. *Trans. Amer. Laryngol. Assoc.*, 22:56-65, 1900.

61. MCKENZIE, MORRELL: Growths in the Larynx. Textbook. P. Blakiston and Son Co., Phila., page 93, 1871.

62. MCKENZIE, MORRELL: A Manual of Diseases of the Throat and Nose, 1880, I:293, London.

63. MARTIN, HAYES: The Treatment of Cancer of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, 213-268, 1936.

64. MEURMAN, Y.: On the Histology of Intrinsic Carcinoma of the Larynx, *Acta Otolaryngologica*, 24:126-134, 1936.

65. MEYERSON, M.: Laryngectomy for Extrinsic Cancer of the Larynx. THE LARYNGOSCOPE, 53:397-399, June, 1943.

66. MONSERRAT, JOSE L.: Epithelioma of the Larynx. *Archiv. Soc. Argent. de Anat. Norm. y Pat.*, 6:19-46, 1944.

67. MOORE, IRWIN: Intrinsic Cancer of the Larynx and the Operation of Laryngo-Fissure. Univ. of London Press, 1921.

68. MORRISON, L. F.: Carcinoma of the Laryngopharynx. THE LARYNGOSCOPE, 62:53-60, Jan., 1952.

69. MOST, A.: Anat. Anzeiger. 1898, page 387. Ibid: *Zeitschrift f. Chirurg.*, Bd. 57.

70. NEW, G. B. and FLETCHER, E. J.,: The Selection of the Treatment for Carcinoma of the Larynx. *J.A.M.A.*, 99:1754-1758, 1932.

71. NEW, G. B.: Symposium on Cancer of the Larynx; Summary. THE LARYNGOSCOPE, 61:523-528, 1951.

72. OGURA, J. H.: Laryngectomy and Radical Neck Dissection for Carcinoma of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, 786-808, Nov.-Dec., 1951.

73. OGURA, J. H. and BELLO, J. A.: Laryngectomy and Radical Neck Dissection for Carcinoma of the Larynx. THE LARYNGOSCOPE, 62:1-52, Jan., 1952.

74. ORTON, H. B.: Cancer of Larynx; Immediate and Late Results in 102 Cases. *Arch. Otol.*, 28:153-192, 1938.

75. ORTON, H. B.: Treatment of Extensive Carcinoma of the Larynx. THE LARYNGOSCOPE, 61:496-510, 1951.

76. ORTON, H. B.: Evaluation of Radical Neck Dissection in Carcinoma of the Larynx. *Trans. Amer. Acad. Ophthal. and Otol.*, 30-34, Jan.-Feb., 1954.

77. PATTERSON, N.: Laryngectomy with Development of Secondary Glands. *Proc. Roy. Soc. Med.*, 30:1393-1394, Sept., 1937.

78. PIETRANTONI, L., NICELLI, F., SBERNINI, C., BOCCA, E., MEDA, P., LEONARDELLI, G., SCEVOLA, P., AGAZZI, C., ROMAGNOLI, M., and PASSINI, C.: Il Cancro della Laringe e dell'Ipofaringe. Clinica Otoringolaringologica della. Universita di Milano. Sopp. XIV, dell *Archivio Italiano di Otologia Rinologia e Laringologia*, Vol. LXIV, 1-336, 1953.

79. PRICOLO, V.: Asportazione in Blocco Quella Laring e dei Gangli Laterocervicoli Monolaterali Chir., 1-5, Nov.-Dec., 1945.

80. ROUVIERE, H.: Anatomy of the Human Lymphatic System. Edwards Bros., Ann Arbor, Mich., 1931.

81. RUBENS-DUVAL and LACASSAGNE, A.: Classification des Cancers Derives des Epitheliomas Cutanes et Cutanes Muqueux. *Arch. Frac. de Pathol. Gen. et Exp. e d'Anat. Pathol.*, Fasc. 4, 1922.

82. SAPHIR, O. and AMROMIN, G. D.: Obscure Axillary Lymph Node Metastases in Carcinoma of the Breast. *Cancer*, 1:238-241, July, 1848.

83. SAPPEY: Quoted in Lennox Browne Textbook. Lea Bros., 1893.

84. SCHALL, L. A.: Cancer of the Larynx. THE LARYNGOSCOPE, 61:517-522, 1951.

85. SCHALL, L. A.: Evaluation of Total Laryngectomy. *Trans. Amer. Acad. Ophthal. and Otol.*, Jan.-Feb., 26-29, 1954.

86. SEMON, FELIX: Malignant Disease of the Larynx. *Dictionary of Practical Surg.* (Heath) 1:895, 1886.

87. SEMON, FELIX: Diagnosis and Treatment of Laryngeal Cancer. *Brit. Med. Jour.*, 1:214-248, Feb., 1907.

88. SNITMAN, M.: Significance of Histopathologic Study in Serial Sections. Prelim. Report, *Arch. Otol.*, 42:178-185, 1945.

89. SYLVESTER-BEGNIS, C.: Tratamiciento Quisurgico del Cancer Laringofaringeo y Vestibular. *Bol. de la Soc. de Cir. de Rosario*, Argentina, 9:649-658, Oct., 1942.

90. TAYLOR, G. W. and NATHANSON, I. T.: Lymph Node Metastases. N. Y., Oxford Univ. Press, 1942.

91. TERRACOL, J. and GUIBERT, H. L.: Epithelioma of the Vocal Cord Invading Arytenoid Cartilage; Histologic Study. *Ann. d'Otol-Laryngol.*, 682-691, July, 1934.

92. TERRACOL, J. and BRINGER, C.: Distant Metastases from Cancer of the Larynx. *Ann. d'Otol.*, 65:1-41, 1948.

93. THOMPSON, ST. CLAIR: Intrinsic Cancer of the Larynx. *Jour. Laryngol. and Otol.*, 36:462-463, Oct., 1921.

94. THOMSON, ST. CLAIR and COLLEDGE, L.: Cancer of the Larynx. Kegan Paul and Co., London, 1930.

95. THOMSON, ST. CLAIR: Subglottic Cancer of Larynx. *Jour. Laryngol. and Otol.*, 52:802-816, 1937.

96. THOMSON, ST. CLAIR and NEGUS, V. E.: Diseases of the Nose and Throat, pages 595 and 637, Appleton, Century and Crofts, 1937.

97. TUCKER, GABRIEL: Cancer of the Larynx. *S. G. O.*, 46:303-308, March, 1928.

98. TUCKER, GABRIEL: Cancer of the Larynx; Observations in 200 Consecutive Cases. *Arch Otol.*, 21:1-8, Jan., 1935.

99. WALSH, T. E.: The Classification of Carcinoma of the Larynx. THE LARYNGOSCOPE, 57:414-418, June, 1947.

100. WILLIS, R. A.: Carcinoma of the Larynx. From Pathology of Tumors, Butterworth Medical Publ., page 303, London, 1938.

101. WORK, WALTER: Cervical Metastases. Symposium on Carcinoma of the Larynx. THE LARYNGOSCOPE, 62:61-74, Jan., 1952.

102. WRIGHT, J.: Microscopic Diagnosis of Intralaryngeal Growth from a Practical Standpoint. THE LARYNGOSCOPE, 19:592-600, 1909.

640 So. Kingshighway.

MICRO-CHEMICAL STUDIES ON NORMAL CERUMEN.† I. THE LIPID AND PROTEIN CONTENT OF NORMAL CERUMEN AS AFFECTED BY AGE AND SEX.

S. P. CHIANG, Ph.D.,*

O. H. LOWRY, M.D.,*

and

B. H. SENTURIA, M.D.,*

St. Louis, Mo.

The chemical composition of cerumen is of interest to otologists, particularly in connection with infections of the external ear. A search of the literature on the subject, however, produced very little information. Most of the work reported[1,2,3] was performed on pooled samples, a procedure made necessary because of the small quantity of cerumen that could be obtained from each subject. With micro-techniques it is now possible to analyze samples as small as 0.2 to 0.3 mg.[4] It is the purpose of this paper to report modifications of these micro-techniques for the study of individual samples of cerumen in order to obtain a clearer picture of their clinical composition. The lipid, protein, and non-lipid non-protein content of normal cerumen from subjects of various ages and of both sexes are presented here in order to ascertain whether a relationship between age and sex and these constituents exists.

MATERIAL AND METHODS.

One hundred and twenty individual samples of cerumen were removed with a curette from the ear canals of clinically normal subjects and preserved in a deep freeze until time of analysis.

The samples were weighed in the following manner: Paper

* From the Departments of Otolaryngology and Pharmacology, Washington University School of Medicine, St. Louis, Mo.

† This research was performed under Contract AF 33(038)-28643 between the USAF School of Aviation Medicine, Randolph Field, Texas, and Washing University School of Medicine, St. Louis, Mo.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, April 22, 1955.

cleansing tissue which had previously been extracted with redistilled ethanol was cut into approximately 1/3 to 1/2 cm. squares and weighed on a quartz fiber micro balance; 200 to 600 micrograms of the samples were smeared onto the center of the tissue and wrapped tightly in order to prevent any undissolved particles escaping into the solvent during the extraction of the lipid. The wrapped wax was then dried under vacuum for 30 minutes and weighed to obtain the dry weight.

Total lipids were estimated by the loss in weight after extraction with redistilled ethanol. After three extractions the residue remaining in the tissue was dried and weighed again, the loss in weight being taken to represent the amount of the total lipids. The protein content was measured on the residue left after lipid extraction using a colorimetric method.[5]

The alcoholic extract was taken to represent the total lipid despite the fact that a portion of the free amino acids was usually extracted along with it. Analysis for amino acids, however, showed that the extracts contain only 2.0 to 3.5 per cent amino acids.

RESULTS AND DISCUSSION.

Tables 1 and 2 illustrate examples of results obtained in analyses for total lipids in pooled and individual samples.

Data for the 120 individual samples classified according to age and sex are presented in Table 3. The results show no significant difference in lipid and protein constituents between the two age groups of children nor is there any indicated between the sexes. When data for the adults and children are compared, the children are found to have slightly higher lipid and lower protein values, but the difference is not statistically significant. Among the adults there is little variation in lipid or protein content in relation to either age or sex. Good consistency is shown in both fractions.

There is marked individual variation among the samples of the same age group as shown by the values of standard errors (see Table 3). The results varied with different samples. In some cases a precision of better than 1 to 2 per cent was obtained whereas in others the range extended to 10 to 15 per cent. The non-uniformity of a considerable number of

TABLE 1.

DETERMINATION OF TOTAL LIPID IN POOLED SAMPLES.*

Sample No.	Tissue Wt.	Tissue + Sample Wt. after Drying	Sample Wt.	Tissue + Sample Wt. after Extraction	Loss in Wt.	% Lipid	Av.	Precision
Tissue Paper	727	727	—	727	—	—		
Sample I	908	1124	216	1029	95	44.0		
	1038	1605	567	1342	263	46.4		
	1142	1815	673	1500	315	46.8		
	1232	1715	483	1495	220	45.6		
	1415	1965	550	1705	260	47.2		
	1205	1750	545	1505	245	45.0	45.8	.021
Sample II	696	868	172	801	67	38.7		
	696	886	190	819	67	35.3		
	656	797	141	749	48	34.1		
	589	793	204	722	71	34.8		
	639	1128	489	953	175	35.8		
	678	868	190	801	67	35.3	35.7	.038

* All the weights are in micrograms.

TABLE 2.

DETERMINATION OF TOTAL LIPID IN INDIVIDUAL SAMPLES.*

Sample No.	Tissue Wt.	Tissue + Sample Wt. after Drying	Sample Wt.	Tissue + Sample Wt. after Extraction	Loss in Wt.	% Lipid	Av.	Precision
N 250	718	1034	316	859	175	55.4		
	643	949	306	779	170	55.6	55.4	0.0037
	639	962	323	784	178	55.1		
N 273	806	1011	205	921	90	43.9		
	779	998	219	903	95	43.4	43.8	0.0053
	731	1038	307	903	135	44.0		
N 274	775	1052	277	886	166	60.0		
	810	1029	219	899	130	59.4	60.0	0.0055
N 277	886	1115	229	1011	104	45.4		
	678	1065	387	890	175	45.2	45.4	0.0029
N 295	771	1038	267	846	192	71.9		
	788	1097	309	877	220	71.2	71.4	0.0046
	903	1205	302	989	216	71.1		

* All the weights are in micrograms.

TABLE 3.

LIPID AND PROTEIN CONTENT OF NORMAL CERUMEN.

Age	Sex	No. of Subjects	% Lipid	S. E.	% Protein	S. E.	% Non-lipid Non-protein
1–7	M	13	50.4	4.4	21.0	2.3	28.6
	F	12	59.7	6.0	17.2	.9	23.1
8–13	M	6	62.2	11.6	16.6	3.3	21.2
	F	7	71.1	8.3	10.0	2.6	19.0
14–25	M	7	53.3	5.5	21.2	2.8	25.5
	F	13	47.9	12.1	22.7	1.7	29.4
26–40	M	10	49.8	3.5	22.2	2.1	28.0
	F	10	52.1	11.3	24.8	8.4	23.1
41–60	M	16	42.7	2.5	23.8	2.0	23.4
	F	8	46.9	6.5	26.4	4.8	28.7
Over 60	M	7	49.6	2.9	25.2	2.2	25.2
	F	11	52.1	3.4	23.7	1.5	24.2
Children 1–13	M	19	54.1	5.1	19.6	1.9	26.3
	F	19	63.8	1.2	13.7	2.2	22.5
Adults Above 14	M	40	47.9	1.9	23.1	1.1	22.5
	F	42	49.8	1.72	24.4	1.3	25.8

the samples is one of the most difficult problems and may be a result of the fact that ear wax is a very heterogenous mixture. Mixing the samples before weighing helps somewhat, but still it is very difficult to obtain uniform samples; therefore when the size of the sample permitted, as many as five or six determinations were performed and the average taken. Wheatley[6] in his study of sebum-like materials of human origin made similar observations regarding cerumen samples.

The nature of the non-lipid non-protein fraction is not yet determined. One possibility is that the unsaturated components of the lipid, on standing in the ear canal, may undergo polymerization, oxidation, or both, thus rendering them unextractable by solvents and lowering the lipid content. The non-lipid non-protein fraction may possibly be used to indicate the degree of freshness of the sample.

The relatively high lipid findings in children disagrees with the widely accepted fact[7] that the amount of fat secreted onto the surface is less in childhood, rises rapidly with the onset of puberty and then levels off to stationary adult values thereafter. The distribution of apocrine and sebaceous glands in the skin lining the ear canal differs from that of skin of the other parts of the body and may partially explain the variations in our findings.

Of significance is the tendency for ear wax to be retained in the ear canals of adults over long periods of time. This occurs less frequently in children. Since the cerumen collected for this study was taken as it occurred in the external ear canal, skin debris, hair follicles and some foreign material were found. These non-secretory substances when present in appreciable amount would influence the percentage of the components.

No definite conclusions have been reached with regard to the effect of age and sex on the fat content of the skin of the adults. Emanuel,[8] Kvorning,[9] and Kirk[10] have indicated that in women there is a significant drop in sebaceous secretion in the older age groups whereas in men no change is observed. A similar trend in the fat content of human hair is demonstrated by Nicolaides and Rothman.[11] Iversen, Videback and Kirk,[12] however, reported that no significant correlation was

noted between age and sex and casual lipid levels on the forehead and on the back of the hand. Our data in the ear canal seem to agree with the findings of Iversen, et al.

Methods are now being sought to collect freshly secreted samples in an effort to circumvent contaminations and changes in cerumen which may occur from prolonged stay in the ear canal.

SUMMARY.

1. With the use of micro-techniques modified for this study, a total of 120 individual samples of cerumen were analyzed for lipid and protein content.

2. The results analyzed according to sex and age indicate that children have slightly higher lipid and lower protein content than the adults but this difference is not statistically significant.

3. Among adults there is little variation in lipid or protein content according to age.

4. There is no significant difference according to sex in either children or adults.

BIBLIOGRAPHY.

1. Nakashima, S.: Uber die Chemische Zusamenstetzung des Cerumens. z. *Physiol. Chemie*, 216: 105-109, 1933.

2. Bauer, W. C.; Carruthers, C., and Senturia, B. H.: The Free Amino Acid Content of Cerumen. Project No. 21-1601-006, Report No. 3, USAF School of Aviation Medicine, Randolph Field, Texas, April, 1954. *Jour. Invest. Derma.*, 21:105-110, 1953.

3. Akobjanoff, L.; Carruthers, C., and Senturia, B. H.: The Chemistry of Cerumen: A Preliminary Report. *Jour. Invest. Dermat.*, 23:43-50, 1954.

4. Lowry, O. H.: A Simple Quartz Torsion Balance. *Jour. Biol. Chem.*, 152:293. 1944.

5. Lowry, O. H.; Rosebrough, N. J.; Farr, A. L., and Randall, R. J.: Protein Measurement with the Folin Phenol Reagent. *Jour. Biol. Chem.*, 193:265, 1951.

6. Wheatley, V. R.: Studies of Sebum. 5. The Composition of Some Sebum-Like Materials of Human Origin. *Biochem. Jour.*, 58:167-172, 1954.

7. Rothman, S.: Physiology and Biochemistry of the Skin. University of Chicago Press, 295-297, 1954.

8. EMANUEL, S.: Quantitative Determination of the Sebaceous Glands' Function with Particular Mention of the Method. *Acta Dermat. Venereol.*, 17:444-456, 1936.

9. KVORNING, S. A.: Investigations into the Pharmacology of Skin Fats and Ointments. II. On the Occurrence and Replenishment of Fat on the Skin of Normal Individuals. *Acta Pharmacol. et Toxicol.*, 5:262-269, 1949.

10. KIRK, E.: Quantitative Determinations of the Skin Lipid Secretion in Middle-Aged and Old Individuals. *Jour. Gerontol.*, 3:251-266, 1948.

11. NICOLAIDES, N., and ROTHMAN, S.: Studies on the Chemical Composition of Human Hair Fat. II. The Overall Composition with Regard to Age, Sex and Race. *Jour. Invest. Dermat.*, 21:9-14, 1953.

12. IVERSEN, K.; VIDEBACK, A., and KIRK, J. E.: Casual Skin Lipid Levels in Individuals of Various Ages. *Jour. Gerontol.*, 8:312-317, 1953.

THE DR. CHARLES BRAMMAN MEDING AWARD.

On the evening of October 28, 1955, The Harlem Eye and Ear Hospital bestowed upon Dr. Franz Altmann the Dr. Charles Bramman Meding Award.

This award is granted annually to the person judged to have made an important contribution for the advancement of Otolaryngology and/or Ophthalmology.

Dr. Altmann's film, "Embryology of the Ear," was considered an outstanding achievement. It was shown at the hospital auditorium coincident with the presentation of the award.

THE MANAGEMENT OF SOFT TISSUES IN TEMPORAL BONE SURGERY.*

KENNETH MCASKILE, M.D.,

Toronto, Canada.

"The craftsman there, the smith with that metal of his, with these tools, with these cunning methods—how little of all he does is properly his work. All past inventive men work there with him; as indeed with all of us in all things."[1]

Temporal bone surgery has reached a high state of perfection in recent years. This has largely been due to improved techniques, better illumination and magnification, the electrically driven high speed drill and the antibiotics. With ever increasing knowledge of the physiology and the pathology of the ear, otologists today are striving to maintain or improve the function of the diseased ear as well as to eradicate the pathology.

To accomplish this it is necessary to preserve the essential functioning anatomy of the middle ear, and by various plastic procedures reconstruct the available tissue in such a manner that the health and function of the ear will be maintained. Many of our failures are the result of improper management of the soft tissues rather than the result of inadequate surgery.

Throughout the past nine years, the essential details of soft tissue management have been of special interest to me. This has included competent instruction, witnessing the surgical treatment in skilled hands, many trials and errors on the cadaver and personal experience with 1,500 cases. The difficulties and failures have all been carefully assessed and certain principles have been accepted as those most likely to bring a successful clinical result. It is indeed the attention to detail and the respect for the function of the various structures that will make this possible.

---

* Submitted as Candidate's Thesis to the American Laryngological, Rhinological, and Otolaryngological Society, Inc., Jan., 1955.

Editor's Note: This ms. received in The Laryngoscope Office and accepted for publication February 1, 1955.

To say that many new ideas are involved would be incorrect, for this is not a primary research problem. The literature and many distinguished authors are quoted, but the surgical technique advised and discussed is that which I use personally, and the results have been assessed solely on this material. The tissues to be considered are the skin, subcutaneous tissue, muscle, perichondrium, cartilage, periosteum, endosteum, dura and facial nerve.

Utmost care must be exercised to avoid unnecessary trauma to the tissue during surgery. Trauma can be minimized by

1. Gentle handling of all tissues.
2. Adequate illumination and exposure.
3. Proper magnification.
4. Maintenance of a dry surgical field.
5. Intimate knowledge of the anatomy.
6. Sharp surgical instruments.

In all temporal bone surgery, preparation of the surgical field is an important factor, and especially so in surgical procedures which are performed for non-infective pathology, such as the fenestration operation for otosclerosis and the destruction of the membranous labyrinth in Meniere's disease.

The night before surgery the hair is shaved for one inch around the ear. The ear and surrounding skin are carefully cleansed with Vel, then washed with alcohol; 1/1000 tincture of Zephiran is instilled into the external canal and the shaved area is painted with the same solution. The entire area is covered with a sterile mastoid dressing. With the exception of shaving, this procedure is repeated on the operating table.

The use of adequate amounts of a suitable antibiotic preoperatively and postoperatively does much to reduce tissue reaction. In infective surgery the proper antibiotic can be selected by bacteriological sensitivity tests. In non-infective surgery the antibiotic of choice is penicillin. It is necessary, however, to determine if the patient has any drug idiosyncrasies. This can frequently be ascertained by a careful history.

SIMPLE MASTOIDECTOMY.

In 1928 Lempert[2] advocated the endaural approach for the simple mastoidectomy. Since that time many articles have been written, praising and condemning the endaural simple mastoidectomy. For the following reasons I feel the post-auricular approach is still the method of choice:

1. More direct access to the mastoid cells.

2. The auricular cartilage is not exposed to the virulent infection which is usually present, and the development of a perichondritis is less likely.

3. Recurrent mastoiditis following the endaural incision may cause a bulging into the external canal making examination of the tympanic membrane nearly impossible. It is then difficult to differentiate between an external otitis, furunculosis or a recurrent mastoiditis.

The post-auricular incision is made a quarter of an inch posterior to the attachment of the auricle to the head, through the skin and soft tissue down to the bone. The temporal muscle must be avoided at the upper end of the incision. The skin and periosteum are then elevated anteriorly and posteriorly.

Using sharp dissection with scissors, part of the attachment of the sternocleidomastoid muscle to the mastoid process is removed. In elevating the skin and periosteum anteriorly, damage to the tissues of the external canal must be avoided or atresia of the canal may result. Bleeding from the soft tissue is then controlled either by tieing the vessels, or with electro-coagulation.

If coagulation is used, particularly near the skin surface, it must be minimal or undue damage to the tissue will result. A post-auricular retractor is inserted and opened carefully. Following complete exenteration of the diseased cells, all loose bone chips are removed. The post-auricular retractor is removed, and again bone fragments are searched for on the soft tissue and removed.

The usual procedure is to suture the upper two-thirds of

the post-auricular incision and insert a rubber drain into the lower end. In 1906 Reik[3] allowed the mastoid cavity to fill completely with blood clot and then sutured the entire incision. Failures were frequent because of recurrent infections. Florey and Florey[4] introduced perfusion of the cavity with penicillin solution. Reading[5] advised allowing a clot to fill the cavity, then suturing completely.

Cawthorne[6] states that during the past 12 years he has stitched up the post-aural wound without any artificial drain, and every case has dried up quickly with early healing of the tympanic membrane and return to normal hearing. Recurrent infection is controlled by the use of the proper antibiotics given systemically. The external canal is packed completely with a strip of gauze ribbon soaked in alcohol. By this method there is rapid healing of the post-auricular incision and cessation of discharge from the tympanic membrane.

Reading[5] states, "The more complete the opening of the cells and removal of the endosteum has been, particularly in the region of the aditus, and the less the postoperative clot has been interfered with by drains or irrigation, the greater the chance of obtaining complete obliteration of the cavity down to the level of the aditus." This method should prevent recurrent mastoiditis, which is stated to be about 10 per cent of all operated cases of acute mastoiditis.

During the last two years I have used the complete closure method on six simple mastoidectomies with healing of the post-auricular incisions by primary intention and with rapid healing of the tympanic perforations. The same post-auricular incision followed by complete closure has also been used in 12 cases of destruction of the labyrinth for labyrinthine hydrops, and in nine cases of decompression of the facial nerve in Bell's palsy, and all have healed by primary intention.

SURGERY OF THE CHRONICALLY DISCHARGING EAR.

Under this heading will be included the complete radical mastoidectomy and the modified radical mastoidectomy. The object of this surgery is:

1. To remove the pathology and to prevent any progression of the disease which might endanger the patient's life.

2. To preserve or improve the hearing.

3. To obtain a dry ear.

4. To obtain a cavity which is entirely lined by squamous epithelium, which has no hidden recesses and which is easily visible through an enlarged meatal opening.

The type of operation performed will depend upon the pathology, the hearing, and the presence of complications or threatened complications. Day[7] states, "make the operation fit the patient. Do not make the patient fit the operation."

The conservative type of radical mastoid surgery associated with such men as Jansen, Corner, Barany, Heath, Bondy, Siebenmann, Ballenger, Richards, Dench and Blackwell did not become popular with otologists until after 1938, when Lempert[8] reported his endaural approach. Since then numerous articles have appeared on this subject indicating the value of conservative operations and the needless destruction of function by more radical procedures.

Failure to achieve the objective stated above by competent otologists is more frequently due to faulty handling of the soft tissues than to inadequate bone surgery. Competence in bone surgery can be acquired by laboratory exercises on the cadaver; however, competence in soft tissue management can be acquired only by practicing on the cadaver, observing the procedure in skilled hands and then conscientiously attempting to accomplish what has been observed.

It is only by diligently following these operated cases over an extended period of time that one is able to observe what eventually happens to the skin graft that was used, the perforation in the tympanic membrane, the tympanomeatal flap and the meatal opening. These things cannot be learned from the cadaver.

Unfortunately the resident surgeons in otolaryngology are more interested in the surgical techniques carried out in the operating room than in the postoperative care in the follow-up clinics. This may be due to the relatively short length of time available to them during their training in the hospital. In my experience, residents who have gone into practice from

our training course have had their chief concern from soft tissue complications such as stenosed meatuses and granulations under the conchal margin, rather than from improper bone surgery. By observing the end results, one is able to correct mistakes made on the operating table and during the early post-operative treatment.

THE INCISION.

The essential of a satisfactory incision is that it should provide the most direct approach to the disease process. This is accomplished by a post-auricular incision in the simple mastoidectomy. In the majority of chronic discharging ears the pathology is primarily located in the middle ear, the attic and the mastoid antrum, and is best approached by the endaural route. Many competent otologists still prefer to use the post-auricular route, claiming that they can accomplish the same results with the same ease as otologists using the endaural approach.

The direct accessibility and good visibility of the endaural approach enable the operator to examine both the anatomy and the changes produced by disease in a minute fashion, and to apply the most refined technique in handling the structures. As a result it is possible to preserve the function of the auditory organ, which is a pronounced feature of the technique.[9]

In certain cases where complications are present or anticipated, or where there is a particularly large cellular development of the tip or retrosinus area, the endaural incision can be combined with a post-auricular incision. At the completion of the operation the post-auricular incision is closed completely and the post-operative treatment is carried out through the endaural incision.

TECHNIQUE.

The operative site is prepared as described previously. In addition the left thigh is prepared the day previous to the operation, in case a skin graft is required. This assures a sterile donor area and saves considerable time and confusion during the actual operation.

ANAESTHESIA.

General anaesthesia is used exclusively for suppurative temporal bone surgery, unless definitely contraindicated. An endotracheal tube is employed in a closed system, which permits the use of electro-coagulation without danger.

PREPARATION AND DRAPING.

The sterile dressing is removed and the operative site is again scrubbed with a solution of Vel. The excess solution is removed from the external canal by suction and tincture of

Fig. 1. Photograph demonstrating a sterile method for fixation of the head in temporal bone surgery. A strip of two inch adhesive is placed over a sterile towel, passing just above the ear and fastened securely to each side of the operating table.

Zephiran instilled. The ear and surrounding area are then painted with 1/1000 tincture of Zephiran.

The positioning and fixing of the head is of utmost importance and should always be done by the operating surgeon. Improper position of the head makes the surgical procedure unnecessarily difficult and dangerous. If the surgeon uses the same position of the head for all surgical procedures on

the temporal bone, it facilitates the recognition of the surgical landmarks and makes illumination and magnification of the operative site much easier.

Once the head is in proper position it can be maintained by the use of a two-inch strip of adhesive placed across a sterile towel just superior to the ear, and fastened to each side of the operating table. The sterile towel is then folded back over the adhesive, leaving a sterile field. The draping is completed by using three sterile towels placed in such a manner that the ear is centered in a small triangle. The patient is entirely covered with a large green sheet, leaving only the ear exposed.

Fig. 2. Photograph demonstrating the sterile towel folded back over the adhesive, with the head firmly fixed in the proper position.

THE ENDAURAL INCISION.

A solution of saline and adrenalin is infiltrated carefully in the following regions to produce hemostasis:

1. Anterior to the helix about 2 cms. superior to the external meatus, first under the skin and then down through the temporal muscle to the periosteum.

2. Post-auricularly at the level of the external canal one injection is made subcutaneously and then extended down to the periosteum. Using the same site of entrance the needle is then directed upwards and anteriorly towards the superior aspect of the external meatus and finally downwards and anteriorly to the inferior aspect of the canal.

3. The rim of the external canal is injected superiorly, inferiorly, anteriorly, and posteriorly.

These injections are made gently, and at no time should the tissues be ballooned out, as this causes unnecessary trauma.

Using a No. 15 Bard Parker blade, a superficial incision is made just deep enough to make a line immediately anterior to the helix extending from a point between the tragus and the anterior crus of the helix. The ear is grasped between the index finger and the thumb of the left hand and moved gently upwards and backwards. This maneuver is repeated several times to determine exactly the anterior border of the conchal cartilage which can be seen moving under the skin.

With the ear held under slight tension upwards and backwards, a curved incision is made down to the bone approximately 6 mm. deep to the margin of the conchal cartilage. This incision begins at the inferior wall of the external canal and extends upwards in a curved fashion and is carried forward just below the incisura for 4 mm. The blade is then rotated at a right angle, and a more superficial incision is carried out through the incisura along the line previously marked anterior to the helix. The incision is made more superficial in its upper part to avoid cutting into the temporalis muscle which would cause unnecessary bleeding.

It is important, however, that the incision around the external meatus should be down through the periosteum. Using an elevator, the fascia is stripped from the temporal muscle anteriorly and posteriorly, then the exposed muscle is freed on its under surface and pushed upwards. The skin and periosteum are elevated posteriorly and inferiorly over the mastoid process.

Using a curved Mayo's scissor with the curve pointing

forward, one blade is placed inside the membranous external canal, the point touching the anterior canal wall, while the point of the other blade is placed on the bony rim of the meatus. The upper part of the membranous canal is then cut open with a single cut. This procedure is then repeated inferiorly to form the outer portion of the meatal flap.

A Sullivan three-bladed self-retaining endaural retractor is placed in position, revealing the temporal muscle superiorly, Macewen's triangle posteriorly, and the meatal flap anteriorly. The two lower blades of the retractor are opened gently until

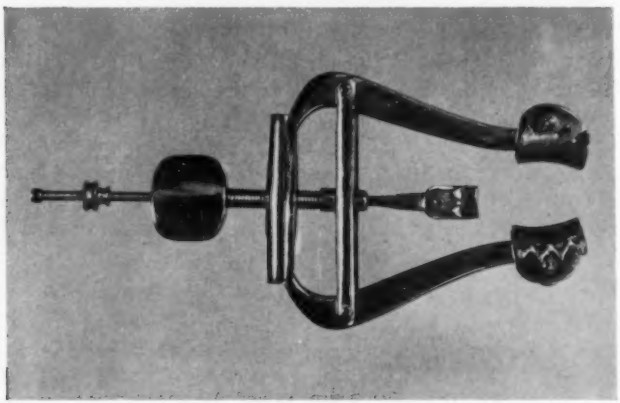


Fig. 3. Sullivan three-bladed self-retaining endaural retractor. The blade to suspend the temporal muscle can be adjusted independently of the other two blades.

the desired exposure is obtained. The third blade is hooked under the temporal muscle which is pulled upwards to the desired level.

It is rarely necessary to stop any bleeding during this procedure, as it is controlled by the injections and the pressure of the endaural retractor. If any undue amount of bleeding occurs it can be easily controlled by a coagulating current; however, this should be used carefully to avoid devitalizing more tissue than is necessary.

The same incision is used for the complete radical mastoidectomy, the modified radical mastoidectomy, and the fenestra-

tion operation. In the complete radical mastoidectomy the tympano-meatal flap is not required as such, but it can be removed when the decision is made to do the complete radical operation. This sometimes cannot be determined until a careful examination of the epitympanic space, the tympanic membrane and middle ear has been done, after the meatal flap has been laid back in the exenterated mastoid cavity. This serves three purposes:

1. A greater number of modified operations can be done because a better evaluation of the pathology can be made at the end of the operation after all areas have been exposed and examined.

2. If the complete radical is done the tympano-meatal flap can be saved in its entirely and used as a free skin graft.

3. It gives the surgeon added skill and experience in the creation of the tympano-meatal flap, which has been one of the great advances in temporal bone surgery.[10]

After the endaural retractor has been placed in position and opened the desired amount to give adequate exposure, the tympano-meatal flap is created. To obtain better visibility of the external canal and the tympanic membrane the following two steps are important: the subcutaneous tissue from the outer portion of the membranous flap is removed with sharp scissors to eliminate the cerumen glands and hair follicles and reduce the bulk of the flap. The upper and lower incisions made previously with the scissors are extended a short distance to give greater mobility and allow the outer part of the flap to be pushed posteriorly so the entire external canal and tympanic membrane can be visualized.

Using a No. 15 Bard Parker blade, an incision is made at 6 o'clock along the floor of the external canal, extending from a point approximately 4 mm. external to the tympanic membrane out to the previous incision made at the lower part of the canal. This incision must be made under direct vision, so the tympanic membrane will not be damaged. It should be done with a single cut directly down to the bone so a sharp, clean incision is obtained.

The next incision is made at 3 o'clock on the anterior canal

wall, extending from a point approximately 3 mm. from the tympanic membrane, out to the edge of the bony portion of the canal, but not into the membranous canal. It is then curved upwards to join the upper incision at 12 o'clock. This incision is best made with a long handled, small curved knife.

Great care must be exercised to avoid cutting into the membranous portion of the anterior canal wall, as it makes the elevation of the anterior portion of the flap very difficult. Cartilage would also be unnecessarily exposed and damage to the temporo-mandibular joint might result.

The membranous flap is separated from the underlying bone, using a fine elevator with a slightly curved tip. The curved tip is directed towards the bone to prevent perforation or tearing of the flap. Two areas are usually difficult to separate, one along the tympano-mastoidal suture line and the other at the anterior meatal spine. The flap is elevated on either side of these areas and then, using sharp dissection with small straight scissors, the fibrous bands are cut as they are encountered, thus avoiding forceful dissection which could easily result in damage to the membranous flap.

If the anterior meatal spine is large and projects into the canal, it should be removed with a 00 curette as soon as the skin is elevated over it to allow direct vision in elevating the remainder of the skin on the anterior canal wall. It will be noted that the flap is very thin anteriorly, but fortunately it can usually be elevated with little difficulty. The separation is continued down to the annulus posteriorly and superiorly. This can be determined by feeling the elevator slip over the edge of the annulus into the middle ear.

The flap is thinned as much as possible, using a small curved scissors and a fine-toothed forcep. It is of great importance that no tension whatever be put on the flap while it is being thinned or it may be torn from its attachment at the annulus. Both sides of the flap must be kept in view to prevent perforating, and only the tissue which is to be cut away is grasped with the toothed forceps. After the thinning is completed the flap is placed against the anterior canal wall and held there by three separate pieces of paraffinized silk. Three things are accomplished by this:

1. The flap is held anteriorly to give better exposure and allow direct attack on the bony canal.

2. It prevents damage to the flap while the bone work is being performed.

3. It keeps the flap free of bone particles.

The flap is cut, elevated and packed forward at the beginning of the operation for the following reasons:

1. It allows direct access to the attic or antrum.

2. The posterior bony wall can be removed with greater speed and with less chance of damaging the membranous lining.

3. Bleeding along the lines of incision will have stopped by the time the bone work has been completed. This is of particular importance in the fenestration operation, where it is important to have no bleeding points after the fenestration has been made.

THE RADICAL MASTOIDECTOMY.

When it becomes obvious, because of the pathology present, that a complete radical mastoidectomy must be done, the meatal flap is removed in one piece as close to the tympanic membrane as possible. It is placed on a piece of gauze and kept moist until the bone surgery is completed. The tongue of skin remaining on the anterior and inferior wall of the canal is removed completely to allow thinning and lowering of the bony canal flush with the floor of the middle ear.

The remnants of the tympanic membrane are removed. This may be used to put in the Eustachian orifice.[7] Before proceeding with any surgery in the middle ear it is necessary to identify the horizontal semicircular canal, the cochleariform process and the Fallopian canal. This can be accomplished by using a small elevator, a fine suction tip and good illumination and magnification. The thickened muco-periosteum and granulation tissue is elevated over the horizontal canal in a posterior to anterior direction.

The facial nerve will be identified in its tympanic portion just anterior to the horizontal canal. It must be remembered, however, that in markedly diseased bones, particularly if cholesteatoma is present, the horizontal canal may be eroded and the facial nerve exposed, even with no history of vestibular disturbances or evidence of facial nerve involvement.

Lempert,[11] states, "In order to obtain a dry ear it is necessary to remove all pathological processes encountered, any one of which when not removed could perpetuate the middle ear discharge." The thickened muco-periosteum must be removed from all areas in the middle ear. This requires exenteration of the peritubal cells, and careful removal of the granulations around the stapes and round window niche.

The stapes must not be dislocated if cochlear function is to be preserved and unnecessary danger to the patient's life avoided. The granulations in the region of the stapes should be removed in a posterior to anterior direction so protection will be given to the stapes by the stapedius tendon.[15] After the granulations are removed the tendon of the stapedius should be cut to give better mobility to the stapes[15] and improve function.

The removal of granulations from the area of the round window niche can only be successfully accomplished if the posterior bony canal wall is lowered flush with the fallopian canal. This removes the bony projection over this hidden area, allowing safe removal of all the diseased tissue without fear of damage to the facial nerve.

It is also necessary to remove the tensor tympani muscle. This can be accomplished by using an S.S. White No. 12 dental excavator. The cochleariform process is fractured off exposing the muscle. The excavator is placed under the tensor tympani muscle, which is completely evulsed from its canal by elevating it in an external inferior direction away from the Fallopian canal.

After the bone surgery has been completed all the bleeding points must be controlled. The entire cavity is flushed with peroxide solution which whitens the cavity and floats out small bone particles. Bleeding in the middle ear can usually be controlled easily by applying cotton pledgets soaked in

1/1000 adrenalin. Small, troublesome bone bleeders are readily stopped by lightly drilling over them with a large diamond burr.

The endaural retractor is taken out, and all the bone chips are carefully removed from the soft tissues by irrigation and suction. This is important, because if these bone fragments are left they cause a foreign body reaction and produce granulation tissue which keeps the cavity discharging and prevents epithelialization. Any bleeding from the soft tissue is controlled by coagulation and the retractor is re-inserted. The Eustachian tube is packed with gelfoam to block the Eustachian tube and support the skin graft.

The skin which was previously salvaged from the meatal flap is thinned carefully and used as a skin graft in the middle ear. This is held in place with paraffin mesh packing. This graft is done at the original operation, because it prevents the formation of granulations which, at a later date when they scar down, can cause fixation of the stapes and round window with resultant loss of cochlear function, and also because the meatal skin is available. If the hearing function is not to be considered, a secondary skin graft, ten days following the original operation when a layer of granulation tissue has formed over the bone, has a better chance of survival.

A thin graft is preferable for two reasons: *1.* It requires less nourishment to survive and will exist in an infected area where a thicker skin graft would die and slough out. *2.* It preserves the function of the oval window and round window niche, because it does not undergo retraction and scarring with fixation which would be expected from a thicker graft. It has one disadvantage, however, and that is its tendency to float out of position when fluid collects beneath it. This does not happen with a thicker graft.

Thin grafts can be handled easily by placing gelfoam over the graft, cutting to the desired size and then placing in position while still attached to the gelfoam. This allows for careful positioning and protects the graft when the packing is removed six or seven days later. The graft can also be handled in the following manner. A pattern is made of the approx-

imate amount of skin that is required to cover the mastoid cavity. A piece of paraffin mesh is moulded into the middle ear, removed, and then placed on the shaped skin graft.

Using the mesh as a carrier the graft is then applied to the cavity by fitting the moulded paraffin mesh again into the middle ear. This gives close approximation of the graft to the middle ear. The remainder of the graft is then packed into place avoiding pressure to the region of the facial canal. This is done by placing a second paraffin mesh pack posterior to the facial canal and parallel to it. The third pack is placed superior to the horizontal canal extending from the antrum to the sino-dural angle.

By this method no packing is placed directly in contact with the facial canal. In putting a skin graft in the mastoid cavity, puckering and folding of the graft should be avoided. This can be accomplished by using a pattern of the cavity to shape the graft, or by using several smaller pieces of skin placed in apposition to cover the cavity completely. Just enough packing is used at this time to keep the graft in position.

Attention is now paid to the meatal opening and methods of keeping it the proper size with a minimal amount of post-operative care and discomfort to the patient. In our series of cases the two commonest causes for continued discharge following temporal bone surgery, whether for suppurative or non-suppurative conditions, were post-operative narrowing of the meatus and the presence of granulation tissue underneath the conchal margin on the soft tissue between the conchal margin and the bony cavity. Both these conditions can be avoided by proper management of the meatal opening at the completion of the operation and during the early post-operative period.

Lempert[8] advises the removal of a triangular piece of skin to widen the meatus. Sullivan[12] removes a triangular piece of periosteum under the conchal margin to allow the skin margin to turn inwards. Shambaugh[13] advocates splitting the upper end of the incision several times during the early post-operative period. Scharfe[14] and others have used acrylic and tantalum obturators in the meatus to prevent stenosis.

These methods prove effective in the majority of cases; however, frequent post-operative examinations are required over a prolonged period to insure an adequate meatal opening and to remove or treat granulation tissue under the conchal margin. If narrowing of the opening occurs, the treatments are difficult and usually quite painful to the patient.

The post-operative contractures and the granulation tissue formations are due mainly to the presence of raw surfaces of soft tissue and bone, which are left exposed at the completion of the operation. The following method has been devised to avoid leaving any raw areas exposed: the endaural incision is made at least 6 mm. deep to the anterior border of the conchal cartilage. This insures that the conchal cartilage will not be exposed during the operation, and also allows sufficient skin to cover the conchal margin and avoid persistent granulations and the possibility of perichondritis.

When the bone surgery has been completed the endaural retractor is removed, the bleeding is controlled, and all free bone particles are removed. Using No. 000 catgut on a curved needle, the posterior margin of the endaural incision is sutured to the periosteum. This is done by first placing the suture through the periosteum at the margin of the bony rim of the mastoid cavity and then just under the skin at the posterior margin of the endaural incision.

Usually four such sutures are sufficient to invert the skin margin and fix it so there will be no raw soft tissue surface posteriorly. The upper part of the endaural incision is sutured in a similar manner to the temporal muscle. When this has been completed the only raw area remaining is a triangular space anteriorly, just superior to the tragus. This area is covered by suturing the skin margins of the triangle together with No. 00000 Dermalon. A thin skin graft is placed in the mastoid cavity to cover all the exposed bone and is allowed to overlap the skin margins of the endaural incision. It is not necessary to suture the skin graft to the margins, as the packing is sufficient to keep it in the proper position.

This method produces a completely skin-covered meatal opening and mastoid cavity. Because there are no raw areas left to permit scarring to take place, the meatal opening will

remain almost the same size when healing is completed. Although this procedure may appear cumbersome and time-consuming in an already lengthy operation, the post-operative treatment period is markedly shortened, and patient discomfort is greatly reduced, as painful methods to prevent meatal stenosis are not required.

The mastoid cavity is packed with paraffin mesh which has been impregnated with an antibiotic ointment. Topical neomycin ointment has been found to be very efficacious in preventing infection and undue odor from the packing. The margins of the meatus are painted with Whitehead's varnish to prevent wetting and excoriation of the skin by the discharge which may ooze from the packing. The ear is coated with neomycin ointment which prevents secondary infection and keeps the dressing from sticking to the ear when it is removed in seven days.

MASTOID DRESSING.

A doughnut or ring of gauze is placed around the ear to prevent its being pressed flat against the skull. Care must be taken when the gauze is applied over the ear to see that the ear is not folded or twisted. This sometimes happens, particularly at the lower part of the ear, and may occur when the bandage is applied. The bandage should be applied in such a manner that it will not slip up and off, or down and cover the patient's eyes.

The patient can be made very uncomfortable by a poorly applied bandage, particularly one that slips down over the eyes. The bandage can be expected to stay in the proper position if the first three turns of the bandage are applied to cover just the upper part of the dressing, passing just above the opposite ear and across the forehead so that half of the bandage is below and half above the normal hair line. The next turn of the bandage covers the lower margin of the dressing, and the remainder in between is covered by subsequent turns of the bandage. If the bandage is too loose it will slip up or down; if it is too tight it will cause headaches and may cause edema of the face on the operated side.

The bandage and dressing are left untouched for seven days. On the seventh day, using sterile technique, the bandage is removed. The area around the ear is painted with tincture of Zephiran and all packing removed, great care being used to prevent movement of the skin graft. Usually very little if any bleeding occurs. The meatus is again painted with Whitehead's varnish and a piece of paraffin mesh the same size as the meatus is reinserted. This is impregnated with neomycin ointment. The head dressing is again applied and left in position for four more days. The patient is instructed not to blow his nose for a period of three to four months as pressure through the Eustachian tube could disturb the graft covering the middle ear.[15]

On the 11th post-operative day the bandage is removed, and the ear and cavity inspected. No attempt is made to enter the cavity or remove any clot or fibrin that may have formed. If fluid has formed under the graft in the middle ear it should be removed by a paracentesis of the graft. Another piece of mesh the same size as used previously is reinserted. It is to be noted that no attempt is made to split open the incision as this is not necessary and is definitely contra-indicated.

On the 14th day the bandage is removed and left off. The cavity is again inspected, but no instruments are placed inside the meatal opening. Any fluid in the cavity is allowed to run out into a sterile piece of gauze. The meatal opening is painted with Whitehead's varnish and the mesh, with neomycin ointment, is inserted. A small piece of sterile absorbent is placed in the concha, and the patient is instructed to replace this cotton approximately three times daily, or oftener if it becomes saturated.

After the 22nd day the patient is seen once a week for a period of three weeks. The mesh may be left out entirely after the 22nd day, but if the cavity is dry it may be left in for five or six weeks, which keeps the cavity clean; however, if there is a moderate amount of discharge the cavity can be cleared up more rapidly by leaving it open to the air.

The patient is instructed to keep the ear and the area around the ear clean by using peroxide to soften and remove

the discharge and to dry the area with 70 per cent alcohol. If the discharge is copious after the first dressing is done it is sometimes necessary to change the dressing oftener and instil some type of antibiotic powder. In our experience best results have been obtained by using terramycin powder; however, chloromycetin, penicillin, aureomycin and neomycin powders have been used. Best results are obtained using the antibiotic in powder form.

In the majority of cases at the end of six weeks the cavity is epithelialized and dry. In some cases, however, it is necessary to remove granulation tissue and cauterize the raw areas with 20 per cent silver nitrate and paint them with a 25 per cent aqueous gentian violet solution. All mastoid cavities should be inspected approximately every four or six months to remove epithelial debris, cerumen and crusts. Following removal of this material the cavity should be dusted with boric and iodine powder. The cavities can be kept clean by syringing with an acetic acid and alcohol solution every two or three weeks as suggested by Farrior.[16]

THE MODIFIED RADICAL MASTOIDECTOMY.

After the tympanomeatal flap has been created and packed forward with three pieces of paraffinized silk, the mastoid cavity is completely exenterated and the posterior canal wall is thinned, lowered and removed. Under magnification a careful examination is made of the antral area. A decision must be made as to whether the incus and head of the malleus should be removed. All the granulation tissue in the area is carefully taken out and the bleeding controlled. All visible cholesteatoma matrix is removed. Much has been written for and against the removal of the cholesteatoma matrix (Baron[17,20b] Juers,[18] Moore,[19] Walsh,[20a] Williams[10]). It is impossible to know what disease or extension of the cholesteatomas is present if all visible matrix is not removed.

It is usually necessary to remove the incus and head of the malleus to allow inspection of all the regions. On numerous occasions after all visible matrix has been removed, when head of the malleus is amputated, cholesteatoma can be found anterior to the malleus which was otherwise hidden. Removal

of the head of the malleus also allows better inspection of the middle ear and makes it possible to seal off the epitympanic space completely at the completion of the operation. There are otologists[11,19,20b,22,23] who feel the disease should be dissected way from around the ossicles. Even if this was an easy procedure, which it is not, there is likely to be disease lurking behind the ossicles which cannot be seen until they are removed.

As stated by Day,[7] the operation must be made to fit the individual case. Whether or not the incus and head of the malleus are removed will depend primarily on the pathology present and its removal. There must be no compromise with pathology. Of secondary importance is the function of the ossicular chain. If it is intact and functioning, then extra efforts should be made to preserve its continuity. If it is fixed or partially destroyed, then the incus and head of the malleus must be removed to eradicate the pathology, and in some instances the hearing will be improved by mobilizing a fixed stapes.

Great care must be exercised in the removal of the cholesteatoma matrix as there may be a fistula into the horizontal canal or complete erosion of a canal. The facial nerve may be exposed and will be particularly vulnerable if the horizontal canal has been eroded. In removing the cholesteatoma matrix from the dura or sigmoid sinus, great caution must be exercised or a dural leak or sinus hemorrhage may result.[24]

In 1,500 cases I have had four dural tears with spinal fluid leak and one sigmoid sinus tear with hemorrhage. All have occurred in cases where pathological exposures were present and where an attempt was being made to remove the cholesteatoma matrix. I have exposed the dura and sinus on numerous occasions in fenestration surgery and have removed granulations from the dura in pathological exposures, where there was no cholesteatoma present, without tears or perforations. It is my opinion that the cholesteatoma matrix causes a thinning or atrophy of the exposed dura in such cases.

The tympanomeatal flap must be elevated anteriorly as far as is necessary to visualize all the areas where disease may

be present. In certain cases it is necessary to dislocate the tympanic membrane partially from its sulcus postero-inferiorly if disease is discovered in the region of the round window. Juers[25] advocates this procedure in certain cases to produce contact between the stapes and the pars tensa to improve the hearing when the incus is absent.

To obliterate perforations that are encountered in the attic region of the tympanic membrane it is sometimes necessary to split the tympanomeatal flap down through the perforation, trim the margins of the perforation and then pack them together. Occasionally when a large perforation is present in the attic region, the blood supply may not be sufficient to nourish the remainder of the flap. If such is the case the outer portion of the flap should be cut off, thinned and placed in the mastoid cavity as a separate graft. This prevents a slough of the flap and also gives the flap that remains a much better chance of surviving.

In a certain number of modified radical mastoidectomies the tympanomeatal flap is not large enough to cover adequately the mastoid cavity. In such instances a separate skin graft should be obtained either from the post-auricular area or from a hair-free area on the thigh and placed in apposition to the tympanomeatal flap. This produces more rapid healing due to the absence of raw areas which frequently produce granulations if left uncovered.

In an attempt to obtain a dry middle ear and maintain good hearing in a patient with a large central perforation, a skin graft over the perforation, using the method described by House[26] may be employed. I have used this method on six cases. In two cases the skin grafts have taken and the perforations have closed. In the four other cases the graft sloughed out very shortly after the packing was removed, and the perforations remained. This procedure requires further investigation.

The modified radical mastoid operation is completed by fashioning a meatal opening similar to that described for the radical mastoidectomy. The post-operative care is essentially the same except that if a tympanic perforation persists, efforts should be made to obtain healing.

THE FENESTRATION OPERATION.

The same incision and meatal flap is employed for the fenestration operation. In general, the creation of the flap is more easily carried out in the fenestration operation as there is usually less bleeding, a better developed bone, and no infection to deal with; however, since the result of the operation depends so much on a perfect tympanomeatal flap there is no margin for error. A small persistent perforation in the tympanic membrane can easily make the difference between success and failure. A tympanomeatal flap which does not survive due either to trauma or poor blood supply, will result not only in lack of improvement in hearing, but may also result in further deterioration with the possibility of a labyrinthitis.

If there is reasonable doubt that a tear in the tympanic membrane will not heal quickly, or that there is not sufficient blood supply to the flap required to cover the fistula, then the fenestra should not be made until the perforation has been allowed to heal and the mastoid cavity has been completely epithelialized. If the meatal flap is longer than necessary to cover the fenestra the outer portion should be cut off to insure good blood supply to the remaining portion. The excised portion can then be thinned and used as a separate skin graft in the fenestration cavity.

Before making the fenestra the flap must be carefully examined for bone dust or chips. This is done by using magnification and a cotton applicator dipped in adrenalin to sweep the flap free of such particles. Where bone particles are adherent to the flap they should be removed with sharp scissors, using either a fine suction tip or fine forceps to hold the fragment.

One of the commonest sources of bleeding during the making of the fenestra, is from the incision made along the anterior canal wall in the formation of the antero-superior portion of the flap. This bleeding can be readily controlled if the incision area is covered with a small piece of gelfoam. During the making of the fenestra, the meatal flap should be kept moist either by flooding the cavity intermittently or by placing a thin piece of moist absorbent cotton over the flap. A considerable amount of heat is produced from the bright

light required for illumination and I think it is important that this tissue be protected from the heat, so damage to the flap will not result.

When the fenestra has been made, the meatal flap should again be inspected for bony particles and then floated into position. A fine suction tip should be available to aspirate any blood that may have collected in front of the meatal flap and to prevent blood in the external canal from entering the fenestration cavity before the fenestra has been properly sealed off.

Lindsay[27] and Lempert[28] have stated that it is necessary for the meatal flap to become adherent to the membranous duct in order to maintain a patent fistula. Various methods have been described. I use a piece of folded paraffinated silk to cause pressure on the flap over the fenestra. This is then held in position with paraffin mesh. If the paraffin mesh alone is used, an open space in the mesh, over the fenestra, would prevent proper adaptation of the flap to the duct. The use of magnification is very important when applying the packing to the flap. It allows for more gentle handling of the packing, more accurate positioning without shifting of the flap and possible shearing of the membranous duct.

In a small fenestration cavity the tympanomeatal flap is usually large enough to cover the exposed bone area, and insure rapid healing; however, in the large pneumatic type of temporal bone it is quite often impossible to limit the size of the fenestration cavity, and in these cases it is necessary to introduce a thin skin graft taken either from the thigh or abdomen. This graft should be fitted in accurately so that all the raw areas of bone are covered. Needless to say the donor area should be carefully prepared to prevent the possibility of introducing an infection into a sterile cavity. After the meatal flap and skin graft, if used, have been properly placed and held in position, the final closure of the cavity is accomplished in the same manner as described for the radical mastoidectomy.

Using sterile technique the first dressing is done on the seventh post-operative day when the outer packs are removed and the last mesh pack over the fenestra loosened. A piece of paraffin mesh is placed in the meatal opening and the bandage

reapplied. On the tenth post-operative day the last piece of mesh and the silk are removed. This must be done with good illumination so the position of the meatal flap will not be disturbed. The mesh is again inserted in the meatal opening and the bandage reapplied. On the 14th postoperative day the bandage is removed and left off.

The fenestration cavity is inspected at weekly intervals following the 14th day, but no instruments are introduced into the cavity unless absolutely necessary. This may be necessitated by the presence of granulations which have to be removed. Blood and fibrin clots are allowed to remain. The meatal opening is kept closed with paraffin mesh for approximately four weeks following operation. The patient is instructed to place a piece of absorbent cotton, lubricated with neomycin ointment, just external to this mesh to absorb any secretion which drains from the fenestration cavity. This cotton is changed as often as is necessary. A definite routine should be established in the care of these cavities if uniform good results are to be obtained.

The two commonest soft tisue complications seen in fenestration surgery are granulation tissue forming behind the conchal margin, and narrowing of the meatal opening. Both of these complications can be reduced to a minimum by proper surgical treatment of the soft tissue structures at the time of operation, so that no raw areas are left exposed. The most important factors are the suturing of the skin margins to the periosteum and the temporal muscle, and applying skin grafts where necessary to cover raw bone and soft tissue surfaces.

A rare post-operative complication is infection. This is prevented by the use of antibiotics prophylactically, and adherence to strict sterile technique, both at the time of operation and at post-operative dressings. Should infection occur a culture should be taken to identify the causative bacteria and its sensitivity determined. Proper antibiotics used locally in powdered form will practically always control the infection without difficulty. The presence of a persistent discharge and granulations in the lower part of the fenestration cavity usually indicates involvement of the tip cells which were not

removed at the operation. If conservative local treatment is not sufficient, it is necessary to revise the area and remove all infected cells, then apply a secondary skin graft. These cavities usually heal very rapidly following this procedure.

TREATMENT OF SOFT TISSUE COMPLICATIONS.

STENOSIS OF MEATAL OPENING.

Stenosis of the meatal opening may occur in temporal bone surgery whether an endaural or postauricular incision is made. The best treatment of this complication is prevention, which can be accomplished by the methods mentioned previously, namely, creating a proper meatal opening and maintaining it by covering all the raw areas either by meatal skin or skin grafts to prevent scarring and retraction.

In addition to the stenosis caused by concentric scarring, a moderate number of narrow openings are seen which have resulted from a downward displacement of the ear as a result of cutting the supporting ligaments and muscles. This allows the membranous meatal opening to fall downward while the bony external canal remains in its normal position. This results in a narrow membranous canal which extends upward and backward at an acute angle. This has been seen more frequently in recent years when unsuccessful postauricular mastoidectomies have been revised by the endaural route, with the result that practically all the normal supporting structures of the ear are incised and the ear falls downward and backward into the mastoid cavity, assisted by scarring and retraction.

To repair a stenosed meatus it is, therefore, necessary not only to create a proper meatal opening but also the ear must be properly positioned and fixed so that it will not be displaced downwards by scarring. The endaural incision is reopened and the scar tissue removed. The periosteum is elevated beginning superiorly under the remains of the temporal muscle. It is very difficult to begin the elevation of periosteum posteriorly due to the presence of the mastoid cavity. Once the bony plate of the skull has been identified under the temporal muscle the periosteum can be elevated backwards and downwards, and the ear mobilized.

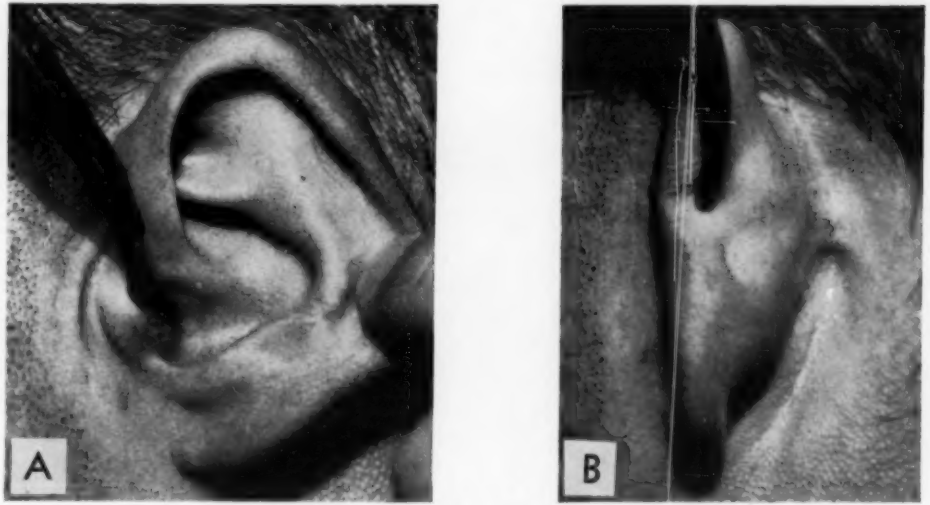


Fig. 4A and Fig. 4B. Appearance of an ear following one postauricular mastoidectomy, with marked narrowing of the external canal due to displacement of the ear downwards and backwards into the mastoid cavity caused by lack of support and scarring.

Great caution is necessary in this procedure if there are any dural or sinus exposures, or if there is a thin atrophic post-auricular scar which is firmly attached to the bone. After the ear has been mobilized and the endaural retractor placed in position the mastoid cavity and middle ear are revised as required and skin grafts are placed over the exposed bone and held in position with paraffin mesh packs.

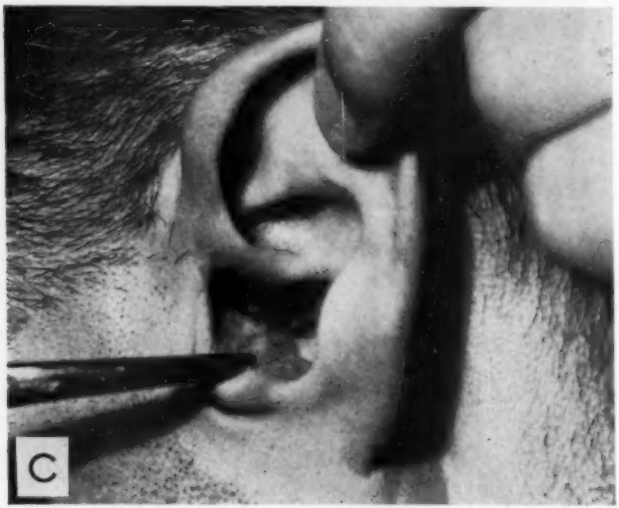
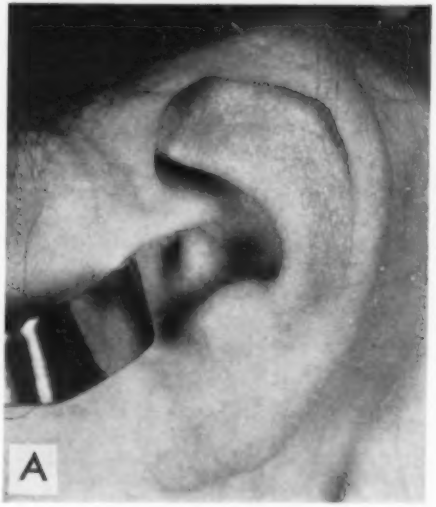


Fig. 4C. Appearance of the same ear following a revision by the endaural technique combined with suspension of the ear and a skin graft in the upper part of the endaural incision.

A second incision is made postero-superiorly to the ear down to the fascia of the temporal muscle. An elevator is passed downward and forward along the fascia to the endaural incision above the incisura. The ear is suspended and the endaural incision held open by suturing the posterior margin of the endaural incision to the temporal fascia, just posterior to the counter incision. Usually four No. 000 plain sutures are sufficient to accomplish the required fixation. The raw areas produced by the stripping of the temporal fascia heal together and fix the ear in its proper position as well as holding the endaural incision well open. A thin skin graft is placed in the upper part of the endaural incision and held in position



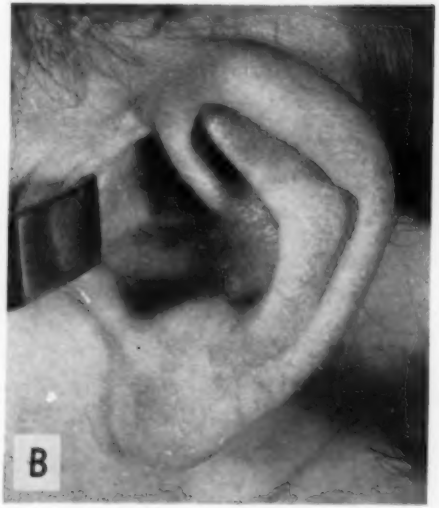


Fig. 5A. Appearance of an ear with congenital atresia of the external auditory meatus. The external meatus is represented by a shallow dimple.

Fig. 5B. Appearance of the same ear following an operation for reconstruction of the external meatus and the middle ear. The endaural technique was used with a thin skin graft in the upper part of the incision combined with a posterosuperior counter incision to suspend the ear and to keep the endaural incision open.

with mesh packing, or it may be sutured with No. 00000 Dermalon.

This procedure can be modified by turning a flap of skin down from the post-auricular area into the endaural incision. This procedure has been used in revisions of mastoidectomies and in eight cases of congenital atresia. It has produced excellent meatal openings without the necessity of using any type of prosthesis to maintain the openings during the healing period. Prior to using this method attempts were made to maintain an adequate meatal opening after operation by using either acrylic, tantalum, or polyethylene prostheses. In most cases granulation tissue formed beneath and internal to these appliances and in addition caused considerable discomfort to the patient. The end results using prostheses were inferior to those obtained by the method just described.

Stenosis of the meatus may also occur as a result of keloid formation along the line of the endaural incision. This presents a very difficult problem in treatment. Revision of the incision with removal of the keloid and skin grafting is the method of choice.

PERICHONDRITIS.

A relatively uncommon complication of temporal bone surgery is an infection of the perichondrium. Perichondritis can develop following either a post-auricular or an endaural incision. During the past year I have treated three cases of perichondritis; two have followed post-auricular surgery and the other endaural surgery. The development of a perichondritis should be watched for diligently, as the final distortion of a neglected perichondritis is disastrous. Early recognition is of utmost importance. Before there is gross evidence of a perichondritis the patient will complain of tenderness and stiffness of the ear.

If the ear is carefully examined at this time there can usually be found a slight, diffuse enlargement of the ear when it is compared to the opposite side. Tenderness on movement of the ear is present which is out of proportion to the appearance of the ear. The entire ear is warmer than normal and has a definite bluish-pink blush. As a rule, no localized cellu-

litis or abscess is evident in the early stages, but if it is allowed to go untreated, a localized area of suppuration will become evident. Infection of the perichondrium is rarely seen until a period of 10 to 14 days or longer has elapsed after surgery.

If the incision is completely extra-cartilaginous there is little danger of a perichondritis developing; however, the necessity for a large meatal opening occasionally requires extension of the incision into the cartilage. If the cartilage is covered by viable tissue at the completion of the operation and suitable antibiotic therapy is used, perichondritis is not to be feared.

At the earliest suggestion of a developing perichondritis hot fomentations should be used continuously. These can be alternated with dry heat supplied by a shaded electric light bulb placed close to the ear. Once there is evidence of localization an incision is made down through the perichondrium and any dead cartilage removed. The incision should be carried through to the posterior aspect of the ear, then through and through packing employed.[29] The infecting agent is usually B. pyocyaneus so the packing is impregnated with neomycin ointment. Fresh packing should be reinserted every other day, until all evidence of the infection has disappeared. This method of treatment has resulted in rapid resolution of the infection with excellent cosmetic results. Conservative therapy with inadequate drainage results in prolonged morbidity and frequently with a marked deformity of the ear.

FACIAL PARALYSIS.

No other structure causes more concern to the temporal bone surgeon than the facial nerve. The fear of damage to the facial nerve in the surgical field has resulted in many inadequate surgical procedures. With the advent of modern temporal bone surgery and a better knowledge of the detailed anatomy, using good illumination and magnification, there is less chance of damage to the facial nerve; however, it is important for the surgeon to be able to recognize any accidental injury that has occurred and to be able to carry out the proper procedures to prevent permanent damage. This may entail

the removal of a depressed bone chip, partial decompression of the nerve, end to end approximation of the severed nerve, or a nerve graft.[30] The proper time to repair these injuries is when they occur and not several days or months following the damage.

If the facial paralysis is evident when the patient regains consciousness the operative site should be revised the following day and the necessary repairs done. If the facial paralysis becomes evident at a later stage it is likely due to increased pressure on the nerve resulting from the packing or due to edema of the nerve itself. Relieving the pressure by loosening or removing the packing will often be sufficient to restore the function of the nerve.

SUMMARY.

1. The success of temporal bone surgery frequently depends on the management of the soft tissue structures. This consists largely of adhering to strict sterile technique, maintaining a dry well-illuminated field and treating all the tissues involved with gentle, meticulous care.

2. In the simple mastoidectomy the post-auricular incision is the incision of choice. It has been my experience that these cases can be completely closed, which results in primary healing of the post-auricular incision and rapid healing of the tympanic perforations, providing the proper antibiotic is employed using an adequate dosage.

3. In temporal bone surgery for chronic otitis media and for otosclerosis, the endaural incision is the incision of choice.

4. Residents who have gone from our training course have experienced the most difficulty from stenosis of the meatus, and the formation of granulation tissue under the conchal margin. The primary endaural incision is of extreme importance in preventing the granulations and stenosis. The careful selection of a line of incision 6 mm. deep to the conchal margin makes it possible to suture the meatal skin to the periosteum, and completely eliminate any exposed cartilage, also to eradicate a probable area for the formation of granulation tissue under the conchal margin.

5. The elimination of all raw surfaces of bone and soft tissue, by the use of a well thinned meatal skin used either as a tympanomeatal flap or as a free skin graft along with thin skin grafts from other parts of the body, prevents scarring and stenosis of the meatal opening and the formation of granulation tissue.

6. The question of removing the cholesteatoma matrix has been carefully considered, and it is felt that it should be removed as completely as possible. It is pointed out that there is definitely a thinning and atrophy of exposed dura, if not actual invasion by the cholesteatoma matrix; and there is a real danger, in its removal, of a spinal fluid leak or a sinus hemorrhage.

7. It has been my experience in six modified radical mastoidectomy operations, where a skin graft was placed over the tympanic perforation, that only two resulted in a closure of the perforation. It is questionable whether this is a larger percentage than could be obtained by using the older methods for closure of tympanic perforations.

8. Two points have been made in the fenestration operation: one is the protection of the tympanomeatal flap from the heat produced by the source of illumination. The second is the attempt to approximate the meatal flap to the membranous duct which has been helped by the use of a paraffinated silk pack directly over the fenestra. Paraffin mesh alone does not accomplish this.

9. The constant attention paid to the removal of all bone chips from the depths of the mastoid cavity and under the skin margin is a simple but important part of all procedures.

10. The two complications of the stenosis of the meatal opening and the displacement downward of the whole auricle have been discussed. A surgical method of plastic repair has been described for these troublesome post-operative results. In our hands this method has offered the best hope of a satisfactory result.

CONCLUSIONS.

The technique of the treatment evolved from the observation of many temporal bone surgeons, cadaver surgery, and the experience of 1,500 cases has been discussed. New methods and ideas do not come in great numbers at any time, and only a few are presented. The surgical treatment of the temporal bone itself has been discussed adequately many times, but this has been an attempt to consider the importance of the adjacent soft tissue structures.

BIBLIOGRAPHY.

1. CARLYLE—The Hero as Poet. Cited by BALLANCE, C. A.: Surgery of the Temporal Bone, Chap. 2, Vol. 1, p. 31. Macmillan & Co., Ltd., 1919.

2. LEMPERT, J.: Simple Subcortical Mastoidectomy. *Arch. Otolaryngol.*, 7:201, March, 1928.

3. REIK, H. O.: *Jour. A.M.A.*, 46:395, 1906.

4. FLOREY, M. W., and FLOREY, H. W.: *Lancet*, 1:387, 1943.

5. READING, P.: Management of Soft Tissues in Mastoidectomy. *Jour. Laryngol. and Otol.*, 67:457, Aug., 1953.

6. CAWTHORNE, T.: Surgery of the Temporal Bone. *Annals of the Royal College of Surgeons of England*, 12:409, June, 1953.

7. DAY, K. M. (Discussion on Moore, J. A.): Endaural Radical Mastoidectomy. *Trans. Amer. Laryngol., Rhinol., and Otol. Soc.*, 57:61, 1953.

8. LEMPERT, J.: The Endaural Surgical Approach to the Temporal Bone. *Arch. Otolaryngol.*, 27:555, May, 1938.

9. MORRISON, W. W.: Endaural Surgery for Chronic Mastoiditis. *Ann. Otol., Rhinol., and Laryngol.*, 51:318, June, 1947.

10. WILLIAMS, H. L. (Discussion on Moore, J. A.): Endaural Radical Mastoidectomy. *Trans. Amer. Laryngol., Rhinol., and Otol. Soc.*, 57:59, 1953.

11. LEMPERT, J.: Modern Surgery of Temporal Bone. THE LARYNGOSCOPE, 60:740, Aug., 1950.

12. SULLIVAN, J. A.: Personal Communication to the Author.

13. SHAMBAUGH, G., ET AL.: A Modified Endaural Incision with Nerve Block Anaesthesia for Fenestration and Mastoidectomy. *Arch. Otolaryngol.*, 45:662, June, 1947.

14. SCHARFE, E. E.: Use of Tantalum in Otolaryngology. *Arch. Otolaryngol.*, 58:133, Aug., 1953.

15. HOUSE, P. H.: Surgery of the Chronically Discharging Ear. *Amer. Acad. Ophthalmol., Otolaryngol.* Instruction Section, 1952.

16. FARRIOR, J. B.: Fenestration Operation Analyzed for Non-fenestrating Otologist. *Arch. Otolaryngol.*, 59:1, Jan., 1954.

17. Baron, S. H.: Modified Radical Mastoidectomy: Preservation of the Cholesteatoma Matrix: A Method of Making a Flap in the Endaural Technique. *Arch. Otolaryngol.*, 49:280, March, 1949.

18. Juers, A. L.: Modified Radical Mastoidectomy: Indications and Results. *Arch. Otolaryngol.*, 57:245, March, 1953.

19. Moore, J. A.: Endaural Modified Radical Mastoidectomy. *Trans. Amer. Laryngol., Rhinol., and Otol.* Soc., 57:44, 1953.

20. Symposium: The Surgical Management of Aural Cholesteatoma. *Trans. Amer. Acad. Ophthalmol. and Otol.*, 57:687-710, 1953.

A—Walsh, T. E.: Why I Remove the Matrix. pp. 687-693;

B—Baron, S. H.: Why and When I Do Not Remove the Matrix. pp. 694-706;

C—Lindsay, J. R.: The Pathogenesis of Cholesteatoma and Summary of Discussion on the Removal of the Matrix. pp. 707-710.

21. Walsh, T. E. (Discussion on Moore, J. A.): Endaural Radical Mastoidectomy. *Trans. Amer. Laryngol., Rhinol., and Otol. Soc.*, 57:60, 1953.

22. Meltzer, P. W. (Discussion on Moore, J. A.): Endaural Radical Mastoidectomy. *Trans. Amer. Laryngol., Rhinol., and Otol. Soc.*, 57-58, 1953.

23. Baron, S. H.: Conservation of Hearing in the Modified Radical Mastoidectomy. The Laryngoscope, 64:365, May, 1954.

24. Ireland, P. E.: Personal Communication to the Author.

25. Juers, A. L.: Preservation of Hearing in Surgery for Chronic Ear Disease. The Laryngoscope, 64:235, April, 1954.

26. House, P. H.: Surgical Repair of the Perforated Ear Drum. *Ann. Otol., Rhinol., and Laryngol.*, 62:1072, 1953.

27. Lindsay, J. R.: Healing of Experimental Labyrinthine Fistulas. *Arch. Otolaryngol.*, 46:584, Nov., 1947.

28. Lempert, J.: Supplement to the *Trans. Amer. Acad. Ophthal., and Otol. Otosclerosis Study Group.* p. 46, Oct., 1950.

29. Sullivan, J. A., and McAskile, K.: Diseases of the Ear, Nose and Throat. W. G. Scott-Brown, Vol. 2, Chap. 12, p. 223. Butterworth & Co., Ltd., 1952.

30. Sullivan, J. A.: Facial Paralysis Complicating Mastoid Operations. *Canad. Med. Assoc. Jour.*, 39:451, 1938.

ACKNOWLEDGMENT.

Acknowledgment is gratefully made to Mr. Arthur Smialowski, Photographic Department, St. Michael's Hospital, Toronto, for the illustrations used in this paper.

174 St. George Street.

THE ATYPICAL EFFECT OF A HEARING AID ON ONE PATIENT WITH CONGENITAL DEAFNESS.

EARL R. HARFORD,*

Newark, N. J.,

and

DONALD M. MARKLE,†

New York, N. Y.

It has been speculated by many clinicians that the high intensity acoustic signal which is presented to the ear by means of a hearing aid may, particularly in cases of perceptive deafness, have a traumatizing effect on the residual hearing and, as a result, may be damaging to the ear. In reference to this speculation, a case is being presented which appears to contribute additional insight to this apparent phenomenon of which there is, at present, only meager information.

R. A. L., an eight-year-old female with bilateral, congenital, perceptive deafness of the familial type, first started wearing a hearing aid at the age of five years; at that time, the audiogram indicated a bilateral loss of equal degree (see Fig. 1 a).

Three years later, one of the authors (E. R. H.) conducted audiometric studies on the child and discovered a significant difference between the two ears (see Fig. 1 b). It is noted that the nonstimulated ear had remained essentially the same throughout the three-year-period, whereas the stimulated ear produced evidence of progressive deafness. At this time, it was recommended that the hearing aid be removed from the left ear and placed on the right.

Following two and a half months of wearing the hearing aid in the right ear, the mother complained that the child's hearing appeared to be getting worse and, as a result, supplementary audiometric studies were conducted. It was discovered that the left ear had recovered to its pre-stimulation threshold, whereas the right ear produced evidence of progressive deafness! (see Fig. 1 c). At this time, the hearing aid was removed from the right ear, placed on the left and, after one week, another audiometric assessment was conducted (see Fig. 1 d). It is

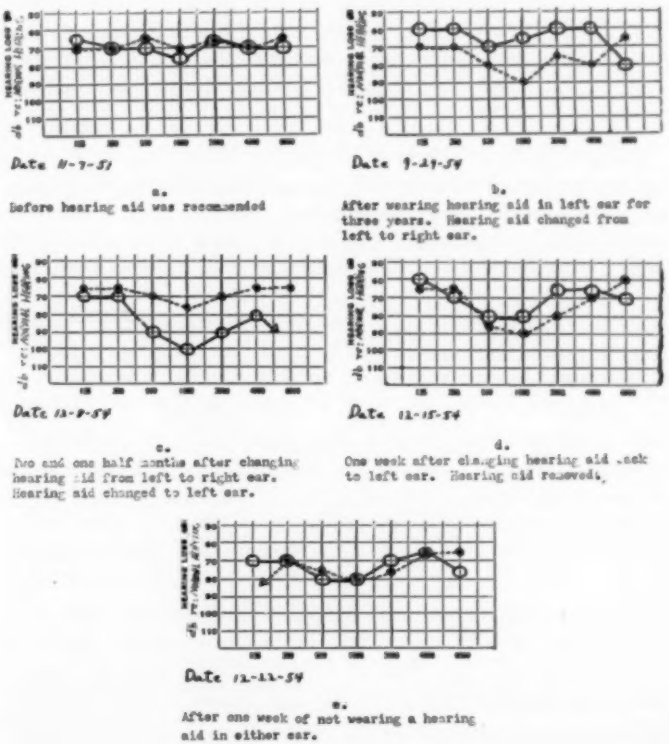
* Audiologist, Rehabilitation Center, St. Barnabas Hospital.

† Supervisor, Speech and Hearing Clinic, Columbia-Presbyterian Medical Center.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication April 13, 1955.

noted that the right ear produced evidence of partial recovery, whereas the left ear indicated a progressive loss. At this time, the hearing aid was removed for a period of one week and, following that time, another audiogram was obtained (see Fig. 1 e). It is now noted that, following this period without amplification, both ears restabilized themselves to essentially the same level of three years previous!

Since the noted threshold shifts lie essentially within the frequency range of stimulation (300-3500 cps), and since the prolonged temporary threshold shift is produced by high intensity acoustic stimuli, it is apparent that this case produces characteristics which are similar to both adaptation and auditory fatigue. Although its significance is not com-



a. Before hearing aid was recommended

b. After wearing hearing aid in left ear for three years. Hearing aid changed from left to right ear.

c. Two and one half months after changing hearing aid from left to right ear. Hearing aid changed to left ear.

d. One week after changing hearing aid back to left ear. Hearing aid removed.

e. After one week of not wearing a hearing aid in either ear.

Fig. 1.

pletely understood, this case supplies us with evidence that such a condition exists and, as such, suggests that more carefully planned studies should be carried out in regard to the effects of amplification on residual hearing. It should be pointed out, however, that this is an atypical example of hearing dysfunction and, until such time that supportive research has been carried out, the reader is cautioned against interpreting this report as evidence supporting the concept that hearing aids may cause damage to the ear.

RUPTURE OF THE BRONCHUS.

JAMES L. SHEEHY, Captain, M.C., U.S.A.*

and

ALAN R. HOPEMAN, Captain, M.C., U.S.A.,†

San Francisco, Calif.

Bronchial rupture caused by a closed chest injury is uncommon, and is usually diagnosed at autopsy or many months or years after the initial injury. Recently there have been reports of bronchial rupture which has been diagnosed within a few days to weeks after the injury and treated by pneumonectomy, plastic repair or re-anastomosis. This is a report on another case, demonstrated bronchoscopically and treated by bronchial resection with end-to-end anastomosis, in which the patient made a complete recovery.

REVIEW OF LITERATURE.

In 1947, Kinsella and Johnsrud[1] reviewed the literature and added two cases of their own, bringing the total to at least 38 patients, 19 of whom recovered. They noted that traumatic bronchial rupture was rare and that it was recognized, clinically, with even greater infrequency. Most patients gave a history of a severe compression or crushing injury with or without rib fracture. Hemoptysis, profound shock, tension pneumothorax, hemothorax, or subcutaneous emphysema often followed.

The right and left main stem bronchi were involved with about equal frequency, usually within one to three centimeters of the trachea, without involvement of the major hilar vessels, or the lung. The majority of the patients received no definitive treatment. As a result, stenosis of the bronchus or complete occlusion with atelectasis occurred.

In 1948, Holinger, Zoss, and Johnston[2] reported three cases in which recovery occurred: two were diagnosed broncho-

* Otolaryngology Service and

† General Surgery Service, Department of Surgery, Letterman Army Hospital, San Francisco, Calif.

Editor's Note: This ms. received in Laryngoscope Office and accepted for publication, May 31, 1955.

scopically and one by bronchogram. Bronchoscopic treatment was attempted in one case, but without success. One patient received no definitive treatment; the other two had pneumonectomy. Both resected lungs (at four months and at three years after injury) showed only chronic atelectasis without evidence of infection.

Paulson[3] in 1951, reported eight more cases in which the patients recovered, and added two of his own. He also noted in one of his patients, treated 10 years after injury by pneumonectomy, the absence of infection in atelectatic lung distal to a complete bronchial occlusion. Two other cases of bronchial repair at thoracotomy have been reported.[4,5]

MECHANISM.

Bronchial laceration from penetrating chest injuries is easy to understand, and the result is usually fatal. Bronchial rupture from closed chest injuries is a different problem: the mechanism may be one of sudden increase in intrathoracic pressure against a closed glottis. This produces either a shearing force at the hilum and a tearing of the least flexible structure, the bronchus, or a sudden increase in intrabronchial pressure with actual rupture of the bronchus. Tension pneumothorax, hemothorax, mediastinal and subcutaneous emphysema, and/or hemoptysis may ensue.

If the tear in the bronchus is not complete, the patient may experience only hemoptysis; atelectasis may develop if a blood clot forms in the bronchus. If obstruction of the bronchus is complete and the organ was normal prior to the atelectasis, infection does not supervene in the atelectatic lung.

DIAGNOSIS.

The most important factor in the diagnosis of bronchial rupture is the awareness of this possibility in any chest injury. The symptoms may be no different from those of a chest injury without bronchial rupture. Mediastinal emphysema, without pneumothorax, should arouse suspicion of bronchial (or esophageal) rupture.

Bronchial rupture should be suspected with tension pneumothorax or hemoptysis in a nonpenetrating chest injury

without rib fracture. Persistent, recurring, or delayed atelectasis following a chest injury is quite characteristic of bronchial rupture.

Once the suspicion has arisen, the diagnosis can be made by bronchogram, bronchoscopy, or thoracotomy. Bronchography in an acute case is unwise, and the information obtained may be equivocal. Atraumatic bronchoscopy, following meticulous local anesthesia, will give much more definite information, particularly since rupture, as reported, occurs only in the main stem.

Thoracotomy as a purely diagnostic measure is not indicated in chest trauma; however, with uncontrolled or persistent tension pneumothorax or intrapleural bleeding, thoracotomy may lead to operative diagnosis of bronchial rupture, as was true in Scannell's case.[5]

TREATMENT.

Most survivors of this injury have received no definitive treatment, the condition being diagnosed in retrospect when stenosis of the bronchus or total atelectasis has been found at autopsy or on routine physical examination years after the injury.

Pneumothorax, oleothorax, or thoracoplasty have been suggested for symptomatic relief in patients with total atelectasis. Bronchoscopic treatment has been carried out,[2,1,6,7] but this has been tedious and unsuccessful except where a thin diaphragm existed which could be incised and would require no further treatment.

Pneumonectomy has been the treatment in four cases[1,2,3] diagnosed four months to ten years after the injury, because of symptoms of chronic atelectasis. These lungs showed only uncomplicated chronic atelectasis, suggesting that re-expansion might have been possible if a repair of the bronchus had been attempted.

Repair of bronchial stenosis after rupture of the bronchus has been reported. Paulson[3] reports a case of chest injury in which a bronchial stenosis developed. Re-expansion of the lung followed plastic repair of the bronchus with a dermal

graft. Griffith[10] did a resection of the bronchus with end-to-end anastomosis seven months after a chest injury in which stricture with obstructive emphysema had occurred.

Weisel and Jake[4] reported a case of bronchial rupture in which complete obstruction of the bronchus developed within 20 days of the chest injury. Forty-six days after the injury, thoracotomy revealed a 6.5 cm. separation of the divided ends. The distal end was opened, the lung was aspirated and inflated, and the anastomosis was done to a window in the trachea, using an endotracheal tube as a stent. Two months later the bronchogram was normal.

The ideal treatment of bronchial rupture is immediate thoracotomy, if feasible, and repair of the injured area. Scannell[5] did a thoracotomy for tension pneumothorax three hours after a chest injury. He found and repaired a laceration of the bronchus. Two other cases of sutured bronchial lacerations are reported.[8,9]

The results from repair, or resection and end-to-end anastomosis, bear out the experimental work of Kiriluk and Merendino,[11] who transected and re-anastomosed a main stem bronchus in 59 animals, and found no evidence of stenosis. The plane of transection and suture material used (gut, silk, cotton) did not affect healing. They demonstrated that interrupted through and through sutures were best, and that the suture lines had adequate strength (to pressure) at three days, and were completely stable by 14 to 21 days.

CASE REPORT.

A 24-year-old man was admitted to Letterman Army Hospital on January 8, 1954, after having been involved in an automobile accident four days earlier. He was initially cared for at a civilian hospital, where he presented a right pneumothorax, fracture of the second and third ribs in the midaxillary line, and extensive subcutaneous emphysema. A tracheotomy was done and catheter drainage of the chest instituted. There was no previous history of chest trouble.

On admission to Letterman Army Hospital his temperature was 101°, respirations were 28, and his pulse was 112. A tracheotomy tube was in place, and there was massive subcutaneous emphysema. The chest tube had been removed prior to admission. There was marked splinting of the right hemithorax, and breath sounds were absent in lower two-third with hyper-resonance above. The mediastinum was shifted to the left.

Laboratory examination revealed a mild leukocytosis and no evidence of anemia. The initial X-ray examination showed fractures of the right

second and third ribs in the midaxillary line, a collapse of the right lung with a fluid level extending to the fifth rib posteriorly, and subcutaneous emphysema.

On admission the patient represented a simple problem of a crushed chest with hydropneumothorax on the right and massive subcutaneous emphysema due to fractured ribs on the right. On the day following admission, 100 cc. of bloody fluid was obtained by thoracentesis. No organisms could be cultured. On the following day another 100 cc. of serosanguineous fluid was aspirated. By January 14, 1954, the chest X-ray was beginning to demonstrate further resolution of the fluid within the right side of the chest without further aspiration. Four days later the subcutaneous emphysema had almost subsided and the tracheotomy was occluded. After 48 hours the tracheotomy tube was removed, and the patient appeared to be well on the road to recovery. He was ambulatory about the ward and complained only of some pain in the right side of his chest.

On January 29, 1954, the patient complained of anterior and posterior midline chest pain. He was afebrile, and there was no alteration of his pulse rate; however, chest films revealed massive atelectasis on the right side (see Fig. 1). Breath sounds were absent in the right side of the chest and only bronchial breathing was heard. The mediastinum was sharply shifted to the right. Tracheal suction was begun, and the patient was placed on antibiotics. He was coughing satisfactorily, but the cough was nonproductive. On January 31, when no progress could be made in relieving the obstruction, bronchoscopy was requested.

Using local anesthesia, an 8 mm., 40 cm. bronchoscope was introduced, revealing a complete block ¾ cm. below the coryna in the right main stem bronchus. This appeared to be inspissated bloody mucus and could not be removed with suction, but irrigation with saline solution resulted in easy removal of the material. There was no bleeding following this, and the bronchoscope was passed further into the bronchus, revealing normal upper, middle and lower lobe bronchi.

Following bronchoscopy, there was a return of the hemothorax and 50 to 75 per cent re-expansion of the lung. Thoracentesis, on February 1, yielded 150 cc. of serosanguineous material. The patient was ambulatory, and by February 7 he had very little dyspnea or chest pain. Later in the day there was a sudden return of all symptoms despite an adequate cough, and X-ray demonstrated a total collapse of the right lung. Tracheal aspirations were again begun, but to no avail, and on the next day (eight days after the first bronchoscopy) bronchoscopy was again accomplished.

The trachea was markedly deviated to the right and a complete block was encountered ¾ cm. below the coryna on the right, where there was a firm gray mass. A biopsy was taken, and the forceps were then insinuated through the mass. This resulted in strong coughing and an immediate shift of the trachea to the midline. Tissue examination demonstrated well developed squamous epithelium on a fibrous stroma that was highly vascular.

The pathogenesis of the stenosis was not recognized, and two days later bronchoscopic dilatation of the area was carried out to a 7 mm. diameter.

The atelectasis cleared markedly following the dilatation, but a review of the records showed that the stenosis was probably the result of a bronchial rupture, and thoractomy was planned in case atelectasis should recur. Eleven days following the dilatation, atelectasis did recur and

bronchoscopy was repeated to give symptomatic relief prior to definitive surgery. The results were minimal.

On February 25, 1954, 52 days following the initial injury, thoracotomy was carried out with left endobronchial anesthesia.* The lung was atelectatic and anteroinferiorly adherent to the chest wall. There had been a complete bronchial rupture with the proximal stump displaced

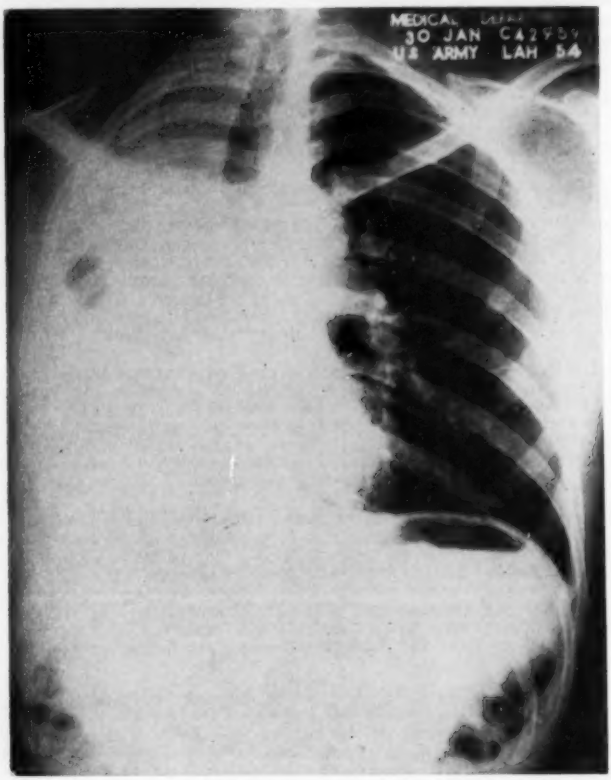


Fig. 1. X-ray prior to first bronchoscopy.

posteriorly. A 2½ cm. section of bronchus, including the stenotic area, was removed, and the purulent material found in the distal bronchi was aspirated. The proximal and distal stumps were anastomosed, using interrupted 000 silk through the entire bronchial wall. The chest was drained, and the patient tolerated the procedure well. The postoperative

* Surgical repair by Dr. Roy Cohn, civilian consultant, Surgery, Letterman Army Hospital, San Francisco, California.

course was uneventful, except for the development of post-thoracotomy chest pain, which disappeared by April 12, 1954, when the patient was discharged to duty. X-ray revealed re-expansion.

On June 9, 1954, the patient was re-admitted to the hospital for X-ray and bronchoscopy. At that time he had no dyspnea, some chest and right arm pain with weight lifting, and 80 per cent of normal vital

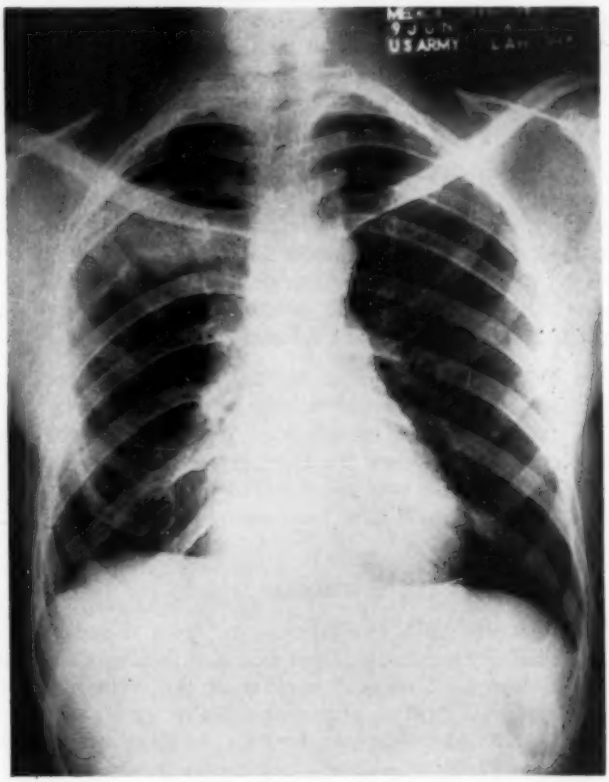


Fig. 2. X-ray 3½ months postoperatively, showing re-expansion with some haziness due to pleural thickening.

capacity. Physical examination was negative except for healed surgical incisions. X-ray revealtd complete aeration of the lung fields with some haziness due to pleural thickening (see Fig. 2).

Laminogram showed 90 to 95 per cent of the normal lumen. Bronchoscopy was accomplished with an 8 mm., 40 cm. Jackson bronchoscope, which passed through the main stem bronchus easily. There was no

evidence of stenosis. The suture line could be seen as a fine white scar with an occasional black suture showing.

COMMENTS.

Apparently the blood in the pleural cavity came from the area of rupture, since bleeding immediately recurred following the first bronchoscopy. It is also apparent that the "fractured bronchus" was splinted by the intraluminal blood clot at the time of the first bronchoscopy, and that removal of this clot resulted not only in bleeding into the pleural cavity but displacement of the "fracture" as well.

This displacement, obvious at thoracotomy, explains the development of complete occlusion by tissue eight days later. Perhaps it would have been advisable, had the diagnosis been suspected, to have left the blood clot alone; however, it seems likely that stenosis, or complete occlusion, would have developed regardless, and it would have been difficult to have established the diagnosis without its removal.

The diagnosis of bronchial rupture should have been made at the time of the second bronchoscopy, and attempts at dilatation should not have been made. There is a much greater chance of infection below the block if the block is incomplete. Although no trouble was encountered postoperatively, a lung free of infection would have been assured if dilatation had not been attempted.

SUMMARY.

The literature on bronchial rupture from closed chest injury, including mechanism, diagnosis, and treatment, has been briefly reviewed. A case of rupture of the right main stem bronchus, demonstrated bronchoscopically and repaired by resection and end-to-end anastomosis 52 days after injury, is reported. There was completely recovery without stenosis of the bronchus.

REFERENCES.

1. KINSELLA, T. J., and JOHNSRUD, L. W.: Traumatic Rupture of the Bronchus. *Jour. Thor. Surg.*, 16:571, Oct., 1947.

2. HOLINGER, P. H.; ZOSS, A. B., and JOHNSTON, K. C.: Rupture of Bronchus Due to External Chest Trauma: Report of Three Cases with Recovery. THE LARYNGOSCOPE, 58:817, Aug., 1948.

3. PAULSON, A.: Traumatic Bronchial Rupture with Plastic Repair. *Jour. Thor. Surg.*, 29:636, Dec., 1951.

4. WEISEL, W., and JAKE, R.: Anastomosis of Right Bronchus to Trachea 46 Days Following Complete Bronchial Rupture from External Injury. *Ann. Surg.*, 137:220, Feb., 1953.

5. SCANNELL, J. G.: Rupture of the Bronchus Following Closed Injury to the Chest; Report of Case Treated by Immediate Thoracotomy and Repair. *Ann. Surg.*, 133:127, Jan., 1951.

6. PRAGET: Cited by Kinsella and Johnsrud.[3]

7. LOFFLER and NAGER: Cited by Kinsella and Johnsrud.[3]

8. LESTER, R. T.: Quoted by Paulson.[3]

9. SHAW, R. R.: Quoted by Paulson.[3]

10. GRIFFITH, J. L.: Fracture of the Bronchus. *Thorax*, 4:105, June, 1949.

11. KIRILUK, L. B., and MERENDINO, K. A.: An Experimental Evaluation of Bronchial Anastomosis and Healing with Special Consideration of Plane of Transection. *Surg., Gynec., and Obstet.*, 96:175, Feb., 1953.

TRANSACTIONS
OF THE
AMERICAN LARYNGOLOGICAL ASSOCIATION
(Scientific Sessions)*
SEVENTY-SIXTH ANNUAL MEETING
MARCH 13-14, 1955
HOLLYWOOD BEACH, FLORIDA
DR. HENRY B. ORTON, President

*Abstracted by SAMUEL SALINGER, M. D., Palm Springs, California.

THE INDICATIONS AND TECHNIQUE OF LYMPH NODE DISSECTION OF THE NECK.

ALTON OCHSNER, M.D.

Metastasis to the regional lymph nodes is very common with malignant lesions about the oral cavity because of the rich lymphatic drainage. Most of these remain localized in the cervical nodes for a long time except in the case of transitional cell carcinomas and lympho-epithelioma, which may metastasize widely very early.

The decision to do a neck resection may at times be difficult to make, because frequently enlargement of the glands may be due solely to inflammatory causes and, on the other hand, metastases may be present without palpable enlargement of the glands. This accounts for the divergence of opinion among surgeons as to the feasibility of prophylactic resection. According to Dr. Ochsner, the procedure is not necessary in cancer of the lip unless the lesion is greater than 3 cc. in size, or is highly malignant. Metastases to the glands are more frequent in lesions of the upper lip than the lower.

In large lesions or anaplastic lesions without apparent gland involvement, a unilateral supra-hyoid dissection is indicated if the lesion is lateral; if in the midline, a bilateral resection would be necessary. In the presence of supra-hyoid involvement, a unilateral neck dissection is done or a bilateral dissection at different stages if the lesion is near the midline.

Neck dissection in connection with carcinoma of the tongue or floor of the mouth may require a supra-hyoid or unilateral neck dissection or even a bilateral resection *en bloc* with the mandible, depending upon the location, extent and type of the primary lesion.

In no case is a neck dissection to be done unless the primary lesion is completely eradicated.

DISCUSSION.

DR. LEROY A. SCHALL inquired as to the complications following resection of the carotid artery and vagus nerve in the complicated cases. He had had five such cases in recent months.

DR. HENRY ORTON asked the essayist for his opinion regarding papillary cyst adenocarcinomas of the thyroid, since there has been some difference of opinion as to proper therapy.

DR. OCHSNER, in closing, replied that when it is necessary to resect the carotid artery, they do so without fear of consequences because of the availability of grafts which can be immediately utilized. Resection of the vagus is a cheap price to pay for the possibility of a cure. Concerning the cystadenomas, he feels that they are truly lymph node metastases from carcinoma of the thyroid rather than aberrant thyroids and should be dealt with by radical excision, frequently bilateral. If the lesion is unilateral it is frequently impossible to palpate the orginal tumor in the thyroid. In such cases he does a hemithyroidectomy, including the isthmus. If a tumor is found in the thyroid they do nothing more, but keep the opposite side under observation for a long time. If no tumor is found they remove the other half of the thyroid and do a bilateral lymph node dissection. He feels that the earlier the lesion is discovered the more radical should be the resection, since this is the best opportunity to obtain a cure.

EVALUATION OF NECK DISSECTION IN CARCINOMA OF THE LARYNX.

LOUIS H. CLERF, M.D.

In a series of 258 total laryngectomies Clerf found that metastases to the regional lymphatics occurred in 25 to 30 per cent of the cases. The five-year survival rate in 34 cases where neck dissection was carried out was 26.4 per cent. Of the 33 not treated surgically but with irradiation only, one survived five years, so that of the total 67 cases with metastases only 15 per cent survived beyond five years. Since 1940 he has been doing a neck dissection combined with the laryngectomy in a greater number of cases than formerly, despite the absence of palpable lymph nodes, with a much higher percentage of survivals. He points out that the cases belonging to this category are those in which the lesion is supra- or infraglottic, or where the arytenoid is involved and the mobility of the cord is definitely impaired. Analysis of the group by five-year periods shows that cases where elective resection was done concurrently with the laryngectomy, yield a much higher percentage of recoveries than those where a secondary resection was performed.

DISCUSSION.

DR. CHEVALIER L. JACKSON said he had every intention of discussing the paper but after hearing it found that he was in complete agreement with the author and could find nothing significant to add to it.

DR. JULIUS W. MCCALL inquired about complications following bilateral resection of the jugular veins. He had seen three such cases in which disastrous brain sequelae had been encountered.

DR. EDWIN N. BROYLES was somewhat dubious about the necessity for gland resections in case of carcinoma of the larynx where the tumor was entirely intrinsic. He had done resections in several cases without finding any metastases in the glands; on the other hand, in cases where the peritracheal glands are palpable it is likely that the thyroid is also involved and, of course, in such cases radical dissection is indicated.

DR. H. H. HARRIS (Houston, Texas) inquired whether Dr. Clerf removes the thyroid gland *in toto* or only the half that appears to be involved.

DR. ANDREW EGGSTON, as a pathologist, brought up the point that frequently it is difficult to appraise the tissue submitted, because the pathologist has no idea of the exact situation of the suspected node in the living state. It would take days to go through the mass section by section to determine the exact location and extent of the metastasis, since frequently it is limited to individual cells. The surgeon who removes the tissue has a much better idea of its relationship to the original focus than has the pathologist. Also a confusing factor is the presence of hemorrhagic foci indicating a noditis which might be mistaken for a metastasis. Thus the difficulty in offering a prognosis based merely on the tissue examination.

DR. JEROME A. HILGER called attention to the complete absence of mortality in the series presented, which speaks volumes for the excellent technique and postoperative care. Increased interest in this type of surgery in recent years brings up the question as to the proper delegation of these cases. Many men have reached the age when they do not care to expand into new techniques. It points to the necessity for proper leadership and the expansion of educational growth among those who are still growing up in the specialty.

DR. CLERF, in closing, pointed out that they did have mortality but not in the selective group. The point is that elective block dissection in conjunction with laryngectomy, when indicated, does not enhance the mortality to any great extent.

Bilateral dissections are fraught with some danger. One case that survived complained of dizziness, had a florid complexion and marked scleral injection. He ultimately died of metastases below the clavicle. Certainly one cannot be too enthusiastic about bilateral block dissection, yet, as Dr. Ochsner stated, it is not too great a price to pay if there is a chance to save a life.

As to Dr. Broyles' comment, Dr. Clerf feels that if the patient has an extensive lesion even though there are no palpable metastases, the chances for a permanent cure are much better if a unilateral block dissection is carried out, since the added risk is minimal. This attitude is prompted by the experience of having patients previously laryngectomized return with inoperable nodes in the neck. Concerning metastasis to the thyroid, the surgeon is definitely behind the eight ball. The operative mortality is increased and the operative procedure prolonged. Certainly the prognosis in such cases is not favorable. Concerning Dr. Eggston's remarks, Dr. Clerf, far from appearing critical, expressed his deep appreciation for the contribution of the pathologist, realizing the great difficulty of accurate and thorough study of all sections of the mass submitted, a matter that is limited by the shortage of personnel as well as time limitations in most hospitals.

MIXED TUMORS OF THE POSTERIOR PHARYNGEAL WALL.

FRED Z. HAVENS, M.D.

and

L. C. BUTLER, JR., M.D.

Mixed tumors of the posterior pharyngeal wall are very rare. Havens and Butler were able to find only 41 cases over a period of 37 years at the Mayo Clinic. The majority occurred during middle life. In 11 cases where the postoperative period was less than five years there was one recurrence. In the 30 cases in which all but one were followed more than five years there were 24 with no recurrence, five recurrences, three of which were successfully treated and two succumbing to the disease. Most of the patients were operated on via the transoral route after preliminary ligation of the external carotid artery, the mass including capsule being scooped out and the cavity left open with only an iodoform gauze pack. Several cases were operated upon via an external approach through the carotid area with primary closure. They believe that the danger of seeding is greater when the latter procedure is employed because of the closure of the operated cavity.

DISCUSSION.

DR. HENRY B. ORTON mentioned a case seen recently in which it was necessary to remove a portion of the ascending ramus of the mandible because of the extent of the growth. It was not necessary to ligate the carotid and the approach afforded much more room than would have been available via the intraoral route.

DR. HARRY P. SCHENCK stated that the few cases he had seen were readily removed by the transoral route. One case was interesting because it had been treated for some time as a peritonsillar abscess. One of the dangers in removing these growths arises out of the fact that the normal mucosa overlying the mass has to be incised to reach the capsule, which is attended by the risk of seeding and subsequent recurrence. Hemorrhage in his experience has not been a disturbing factor. Following removal, one may be astounded by the depth of the resulting cavity. Dr. Schenck has practiced suturing from the bottom up and obtained very satisfactory cosmetic results.

DR. ALBERT C. FURSTENBERG emphasized the importance of thorough eradication at the first attempt because recurrences are usually found in areas remote from the original focus, which increases the difficulty of removal. Besides, the recurring growth is usually more malignant than the original.

He agrees that seeding may be a very potent factor in the incidence of recurrences. It is, therefore, advisable, particularly if the mass is in one of the salivary glands, to remove some of the tissue surrounding the capsule of the tumor even though it may appear grossly benign.

DR. DEGRAAF WOODMAN asked Dr. Havens' recommendations as to biopsies in view of the danger of seeding.

DR. HAVENS closed the discussion by stating that he had at times been tempted to attack the tumor via the external route as suggested by Dr.

Orton but had thus far not encountered a case when this procedure was imperative.

As for ligating the carotid, it depends on how readily one is alarmed, which was the case in his own experience on several occasions. He would, therefore, feel more secure if he ligated. The matter of closing the defect is one that may be left to the individual. Dr. Havens does not suture, but fills the cavity with iodoform packing which is removed gradually beginning on the fourth day. The wound heals readily, and at a later date one can barely see the operated area. He believes also that there is less danger of seeding.

Dr. Havens agreed heartily with Dr. Furstenberg on the matter of adequate surgery at the first attempt. This applies to all malignant tumors as well. Concerning the question of biopsies he is in the habit of sending a biopsy specimen out after the capsule has been identified and the dissection partly completed. As a matter of fact it makes little difference since the excision is going to be wide enough to encompass all the presenting mass.

VASOMOTOR RHINITIS.

THEODORE E. WALSH, M.D.

Walsh has been unable to identify allergic factors in a large percentage of the cases of vasomotor rhinitis which he has observed. In most cases the etiology is to be found in endocrine, dietary and psychosomatic disorders. Hypothyroidism, often of the subclinical level, is very common and good results may be expected following the administration of thyroid extract in adequate doses. In children dietary indiscretion, such as the ingestion of excessive amounts of carbohydrates, is frequently the cause. Emotional states should not be overlooked, because in many instances they act as a trigger mechanism that sets off allergic manifestations in many individuals who are only mildly allergic without showing specific sensitivity.

The author decries the continuous use of vasoconstrictors which only leads to subsequent turgescence. He advises propadrine by mouth for temporary relief in addition to the care of such constitutional factors as have been mentioned.

DISCUSSION.

DR. OLIVER E. VAN ALYEA expressed his opinion that the condition described by Dr. Walsh was a borderline or atypical allergy and might be considered as a separate entity. A question he would like to raise apropos of therapy relates to the employment of cauterization of the turbinates in stubborn cases. This is an old time procedure of which he does not approve.

DR. HENRY L. WILLIAMS agreed that many of these cases are difficult to relieve. It occurred to him that it might be possible to differentiate among them a little more accurately. In his experience the cases with violaceous mucous membranes are usually the so-called low BMR without myxedema which can successfully be treated. On the other hand, the cases with watery discharge and relatively normal mucosa are not helped by endocrines, and are better classified as physical allergy. The insistence of Dr. Walsh on antigen-antibody reactions is not in line with the think-

ing of immunologists. The concept of physical allergy cannot be disproven, and allergists are willing to admit that many of these cases which are clinically indistinguishable from true allergy do not yield a positive skin test. The dietary regimen mentioned by Dr. Walsh is reminiscent of Dr. Sam Roberts' work along these lines, which has proven to have great merit. As for cauterization, mentioned by Dr. Van Alyea, Dr. Williams has found it efficacious particularly if applied in the region of the sphenopalatine ganglion. He has seen no ill effects from the procedure, there being no permanent damage to the cilia, and it affords relief for long periods of time.

Dr. Lowenthal called attention to possible emotional or psychiatric influences in these cases. Frequently the patient will give a history of spastic colitis or some other derangement of the sympathetic nervous system. A pseudo-psychiatric approach may in many instances afford the key to a solution of the problem.

Dr. Walsh, in closing, agreed that cauterization of the ganglion is free from harm and is not to be confused with cauterizing the turbinal, which may alter the physiology of the mucosa. He personally likes injecting the ganglion, which has given him some very good results. Concerning physical allergy, Dr. Walsh felt incompetent to discuss it adequately, although he recognizes it as an entity; however, these cases are a minority in the group he was discussing. He agrees that the psychosomatic approach has much to offer, yet does not mean that they all must consult a psychiatrist. The solution to the problem lies in a thorough understanding of the patient as a whole, knowing his background, habits, environment and emotional status. Frequently the trouble is due to a combination of factors aside from the purely allergic.

A FEW HIGHLIGHTS CONCERNING RESPIRATORY CILIA.

G. Edward Tremble, M.D.

The electron microscope has in recent years proven of great value in determining the structure of cilia. "Each cilium consists of a basal body which is imbedded in the cell. Just above the basal body a small cuticular ring can often be seen." The rings of adjoining cells seem to be attached to each other forming a thin plate. "The cilium itself consists of an axial fibrillar bundle and a semitransparent, thin peripheral sheath."

Much of the experimental work on animals is described in the article.

It is assumed by some that the activating agent which produces the ciliary beat arises in the basal bodies and is transmitted through the longitudinal fibrils to the tip of the cilia. The question as to the exact origin of the cilia is still undetermined; we do not know whether they grow from the surface of the cell or develop below in the basal body; also still a mystery is the exciting influence which causes the ciliary beat.

DISCUSSION.

Dr. August L. Beck recalled an early motion picture produced by the late Dr. Mosher in which one cell had become detached and was still

showing activity, the cilia continuing to beat in rhythm with the rest of the cilia along the main body of cells. It reminded him of a soloist and orchestra in action through some unseen agency.

DR. ARTHUR W. PROETZ called attention to the value of the electron microscope, which has in recent years vastly increased our knowledge of ciliary activity. The time now is ripe for some genius to unravel the mystery of the true origin and nature of ciliary activity. If requires not only the electron microscope but also an observer with imagination who can put together such facts as Dr. Tremble presented along with other data. The situation is almost analagous to the study of the circulatory system, in which all the facts were known for years but not clearly understood until someone discovered valves which finally proved that the blood was going in one direction.

DR. TREMBLE closed the discussion by acknowledging Dr. Beck's comment about the continual activity of cilia even when the cell is detached. This observation of Dr. Mosher's has been corroborated many times since. By having a patient with a cold blow his nose onto some wax paper and placing the secretion under the microscope, one may frequently see detached cells with cilia still waving. They will continue to wave as long as attached to protoplasm, kept warm and moist. His object in bringing this subject before the Association was to emphasize the constancy of cilia throughout the animal kingdom, as shown by comparison with spermatozoa with its fringe-like tail and the nine paired groups around the periphery with the two larger central ones, just like the cilia in our own nasal mucosa.

THE RADICAL OBLITERATIVE FRONTAL SINUS OPERATION: A CONSIDERATION OF TECHNICAL FACTORS IN DIFFICULT CASES.

ROBERT L. GOODALE, M.D.

Dr. Goodale proposes a radical obliterative operation in which the Jansen-Lynch-Smith procedures are inadequate, cases of extensive trauma, chronic osteomyelitis and recurrences following previous surgery. The previous objections to this method, namely, the resulting deformity, can be overcome with modern plastic procedures. The obliterating operation must be complete, all mucosa and bony septums removed, the duct destroyed and the ethmoids exenterated. The posterior wall of the sinus is not removed unless apparently diseased, or where there is a suspicion of some intracranial extension. Eight cases are shown in which the excellent plastic repair of the defect demonstrates the fine cosmetic results obtained. In most cases autogenous bone grafts were employed.

DISCUSSION.

DR. JAMES M. ROBB said that Dr. Goodale's paper has shown definitely that it is an erroneous concept to conclude that the sulfa drugs and antibiotics have completely done away with the necessity of operating on the frontal sinus.

DR. W. LIKELY SIMPSON felt that while 100 per cent perfect postoperative results were impossible, the usual course after a proper procedure should be as good as that following a radical mastoid. Such factors as the extent of the disease of the bone and membrane, as well as the size of the

sinus, have a definite bearing on the post-operative course. It is imperative that all of the mucous membrane be removed and the entire ethmoid area exenterated. As for osteomyelitis, it is better to defer the definitive surgery until the acute process has been brought under control. Through the usual brow incision the exenteration can be accomplished, starting from the upper extension of the sinus and working downward. The polishing burr is a useful adjunct in the finishing process. Where the sinus extends far upward it is advantageous to make the incision at the supreme extremity, which affords good access and which leaves very little scar or deformity. Cases are frequently presenting themselves which require the type of surgery described by the essayist, and the individual surgeon should have the courage to go ahead when the case demands it.

Dr. Francis W. Davison recalled a technique described by Dr. Jesberg a few years ago, in which the floor of the sinus is removed along with the outer third or half of the anterior wall, a procedure which is indicated and has been proven successful in the large or expanded sinus.

Dr. James Maxwell stated that in recent years they have attacked the large frontal sinuses via a coronal incision which permits excellent exposure of the entire frontal bone and, if the orbital ridges are removed, affords access to all the ethmoids and sphenoids. He asked Dr. Goodale whether with the brow and vertical incisions it was his practice to pack the wound wide open.

Dr. Goodale closed the discussion by first agreeing with Dr. Robb that too much reliance has been placed on antibiotics by some surgeons, particularly in chronic cases, gross infections, etc; besides, antibiotic therapy needs reviewing in the light of the emergence of resistant strains and new bacterial invaders. Certainly the pyocyaneous and resistant staphylococcic infections call for more effective medicaments than at present available. He was interested in Dr. Simpson's use of the burr. Having been trained in the use of gouge and rongeur, he had clung to them because of his familiarity with them; nevertheless, the idea of using the burr particularly from above, seems appealing. The important point is to see that the utmost limits of the sinus are reached.

He recalls one case of a chronic frontal sinusitis with a localized osteomyelitic process in which the Jesberg procedure worked out very well although some deformity did result.

He agreed with Dr. Maxwell that the coronal incision can afford a wide exposure; however, in the cases he has presented it seemed more feasible to go through the incisions of the previous operations rather than make new ones. In the one case in which a vertical incision was used, it was necessitated by the fact that after the Lynch exposure it was found that an osteomyelitic process was present not previously seen in the X-rays.

Motion Picture Film

REHABILITATION OF PATIENTS WITH CLEFTS OF THE LIP AND PALATE.

(No formal paper)

(No discussion)

UNILATERAL CORD PARALYSIS.

DANIEL S. CUNNING, M.D.

Dr. Cunning studied a series of cases of vocal cord paralysis observed at the Manhattan Eye, Ear and Throat Hospital over a period of 15 years. There were 163 males and 99 females; 82 involved the right cord and 180 the left. The etiologic factor was found in 68.7 per cent of the group, the remainder being unidentified. Neoplastic and toxic or inflammatory lesions accounted for almost half the cases.

A search for the etiologic factor must include a thorough physical, X-ray, neurologic and serologic examination. The causes are too numerous to mention, since any lesion from the nuclear and supra-nuclear areas in the brain and on down along the course of the vagus may affect the functioning of the nerve, which may also be involved in any number of general constitutional disorders of a toxic nature.

DISCUSSION.

DR. LOUIS H. CLERF recalled a statement made by Dr. Kyle years ago that the general physician sees this condition from the systemic standpoint, while the specialist looks at it as a local affair which he often treats without realizing its significance. Dr. Cunning's statistics agree with previous studies, namely, that neoplasms are the cause in two-thirds of the cases, the others being considered idiopathic. While there is not much to be done for the neoplastic group, the laryngologist can be of great assistance to the thoracic surgeon who realizes that left-sided paralysis due to thoracic lesions rarely is amenable to surgery. Dr. Gibbon, who has explored many of these cases, has yet to find one which he could successfully extirpate. Another interesting item is the occurrence of a left-side paralysis five to ten years after a mastectomy, indicating an inoperable mediastinal extension. As to post-thyroidectomy paralysis, it indicates the importance of the surgeon learning more about the recurrent nerve. The toxic group of cases is interesting, since many of the idiopathic cases are of this nature, being probably due to a virus. These cases offer a better prognosis than many of the others. Dr. Clerf agrees with Dr. Cunning as to the value of speech therapy in some of these cases. Surgery such as that recommended by Dr. Morrison can be successful in improving the voice when the cord is abducted with poor tension.

DR. EDWIN N. BROYLES mentioned a case of spontaneous unilateral paralysis in which the examination offered no clue as to the cause until eight months later, when a mass developed in the thyroid region which proved to be malignant. In another case of unilateral paralysis it was a year before a tumor of the mediastinum was diagnosed. It might be feasible in such cases to explore the left recurrent nerve and follow it down into the chest in the hope of finding the lesion. It is his opinion, as well as that of surgeons of his acquaintance, that tumors of the thyroid causing a recurrent paralysis are usually malignant. As for patients being improved by speech therapy, this may be true of the speaking voice but is usually ineffective insofar as the singing voice is concerned.

DR. C. L. JACKSON reported having seen two cases on successive days in which the etiology could not be determined. He inquired whether Dr. Cunning had had any results from medical therapy in the toxic or inflammatory cases.

Recurrent paralysis following diverticulectomy had disturbed him in

several cases and he wondered whether the essayist had anything to offer by way of preventing this complication.

Dr. Julius W. McCall thought that unilateral paralysis caused a voice weakness rather than a true hoarseness, because he has observed that these patients have a better voice in the morning than later in the day.

Dr. Benjamin Shuster mentioned a case in which neurologic findings pointed to a brain tumor; however, a more careful study of cranial nerve function and the reaction to skin stimuli revealed a loss of sensation on one side which pointed to a spinal thalamic involvement on the side opposite the cord paralysis.

Dr. Francis L. Weille asked Dr. Cunning whether he attached any significance to the anastomotic branch from the superior to the inferior laryngeal nerve insofar as explaining the position of the cord after injury.

Dr. Cunning closed the discussion first by evaluating what he called hoarseness. The character of the voice in larynx lesions often varies with the lesion within wide limits. So far as he is concerned he can only call it hoarseness, though in some cases it may be partly fatigue.

It is true that about 10 per cent of the cases are caused by cerebral or spinal lesions, and, therefore, it is always important to check all the reflexes for possible signs pointing to the side of the lesion. As for medical treatment, they have used iodides, vitamins and Cortisone, all with no effect. There were no cases of paresis complicating diverticulotomy in his series.

There is no question that the laryngologist is up against it in so many cases because of the difficulty in discovering the etiology. These patients often go for years with no other symptom than the hoarseness.

TEN YEAR PROGRESS OF LARYNGOFISSURE OPERATION.

Mercer G. Lynch, M.D.

Experience with the laryngofissure operation in recent years has yielded a higher percentage of cures up to 90 per cent. This has been accomplished through wider excision of tissues. Where the commissure has been involved a portion of the cartilage is removed and the excision extended into the opposite cord. The possibility of a web resulting is not viewed with any alarm since the McNaught procedure with the tantalum plate has proven its worth. Dr. Lynch does not recommend its being done at the primary operation because of the granulation tissue which springs up in abundance from the irritation of the tissues by the metal. It is better in these cases to await scar formation before attempting to insert the tantalum plate. Laryngofissure can be successful even in cases where the growth has extended as far as the vocal process and even when mobility of the cord is limited; however, if the arytenoid itself is involved or mobility is definitely limited, one would have to choose laryngectomy in preference. It is important to resect well beyond the apparent lesion, and Dr. Lynch recommends following the surgery with the application of electrodessication; also he calls attention to the fact

that tracheotomy is not resorted to, which materially reduces the postoperative period.

DISCUSSION.

DR. CHEVALIER L. JACKSON was glad that Dr. Lynch had raised his voice in favor of the laryngofissure operation. The indications for it have broadened rather than contracted because of broadened techniques. The elder Jackson's technique of removing anterior commissure lesions has been improved since Broyles described the anterior commissure tendon, so that now, instead of cutting the cartilage in the midline, the incision goes through the healthy side, thus permitting excision of the midline cartilage along with the lesion. Regarding web formation following thyrotomy, he has found the procedure suggested by Dr. Gabriel Tucker of value, namely, anchoring the epiglottis forward with a suture in all cases where its attachments have been severed; also, Dr. Jackson pointed out that this operation should really be termed a partial laryngectomy rather than a laryngofissure.

DR. HENRY M. SCHEER called attention to a procedure described by his son, in which the laryngofissure approach was employed for the relief of a bilateral abductor paralysis. One paralyzed cord was tied back with a wire suture, and the patient for three years was still breathing comfortably through the larynx.

DR. LYNCH, in closing, stated that he does not favor a hemilaryngectomy in cases where the midline incision is not indicated. He would prefer laryngectomy in such instances. With regard to web formation, he has not employed Dr. Tucker's procedure but has used the tantalum splint with good results. As for Dr. Scheer's operation, Dr. Lynch recalled the submucous dissection of one cord reported by Dr. Hook of Boston, in which some good results were obtained.

(To be concluded in the November Issue.)

THE VIRGINIA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

The Virginia Society of Ophthalmology and Otolaryngology will have its annual fall meeting in Richmond at Baruch Auditorium in the Medical College of Virginia, Nov. 29th and 30th (Otolaryngology) and Dec. 1st and 2nd (Ophthalmology).

The speakers for the Otolaryngology program are: Drs. Victor Alfaro, Lawrence R. Boies, Aram Glorig, Robert J. Huebner, Lyle M. Sellers, Ben Senturia, and Henry L. Williams.

The speakers for the Ophthalmology program are: Drs. Howell W. Brown, James Spencer Dryden, Wm. M. Hart, Wm. Howard, Edward Norton, and Henry P. Wagener.

Additional information may be had by writing Dr. P. N. Pastore, Box 25, M. C. V. Station, 1200 E. Broad Street, Richmond 19, Va.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

PROGRAM 1955 - 1956

Tuesday, November 1, 1955

Amon Carter Airport — Private Dining Room

Joint Meeting with Fort Worth E.E.N.T. and Dallas O. and O.

Dr. Harold F. Schuknecht, Detroit, Mich.
Associate Surgeon, Henry Ford Hospital

3:30 P.M.—Program: Meniere's Disease

4:30 P.M.—The Management of Carcinoma of the Upper Respiratory Tract

5:30 P.M.—Cocktails, Courtesy Alcon Laboratory

6:30 P.M.—Dinner honoring Dr. Schuknecht

7:30 P.M.—The Clinical and Experimental Aspects of Perceptive Deafness

---

II INTERNATIONAL CONGRESS ON ALLERGOLOGY.

The II International Congress on Allergology will be held in Rio de Janeiro, November 6-13, 1955. The most outstanding authorities on the matter will be present at this meeting, with a view to submitting and considering the following official subjects: Histamin and Mechanism of the Allergological Reactions—(histamin, its metabolism and its rôle on the allergology; histamin releasers. Drug Allergology, including the antibiotics). Immunology and Allergology (chemical compositions of the antigenes and antibodies; immunological quantitative technics applied to allergology). Asthma (physiopathology, death through asthma; climatic asthma). Dermatological Allergology (including industrial and contact dermatitis). Allergology and Verminosis. Allergology and Leprosy. Allergology and Tuberculosis. Allergology and Hormones.

Prior to the opening of the Congress, on November 3-5, an international and intensive course on allergology will be held, in which about thirty famous scientists will participate. The Congressists, by addressing themselves to the Congress Secre-

tary-General, will be considered as registered in this course. All other interested parties (physicians or medical students) are requested to register their names, in due time, at the General Secretariat.

Registration fees: U.S. $15.00. Accompaniers: U.S. $6.00 each.

For further information and registration, please apply to:

Secretaria Geral do
II CONGRESSO INTERNACIONAL DE ALERGIA
Avenida Rio Branco 277, 7° andar—grupo 705
Rio de Janeiro - Brasil.

THE VIRGINIA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY CONVENTION CRUISE

The Virginia Society of Ophthalmology and Otolaryngology is sponsoring a convention cruise to Havana and Nassau on May 26 to June 2, 1956. Sailing from and returning to Norfolk, Virginia, the "Queen of Bermuda" will act as the hotel for the trip. Fare for seven days, $165.00 and up per person. Make reservations with United States Travel Agency, Inc., Washington, D. C.

STANFORD UNIVERSITY SCHOOL OF MEDICINE POSTGRADUATE COURSE.

A Postgraduate Conference in Otorhinolaryngology will be presented by the Division of Otorhinolaryngology, Stanford University School of Medicine, March 26-30, 1956. This Conference will offer a comprehensive survey of the current field of Ear, Nose and Throat. Presentations will be didactic, by individuals and panel-groups. Some of the subjects will be: basic science reviews, such as anatomy (using three-dimensional projection) and pathology; audiology including psychogalvanic skin response; ear surgery, including stapes mobilization; nose and sinus problems, including rhinoplasty; pituitary surgery; allergy and steroid therapy; throat diseases including suspension laryngoscopy, laryngoplasty (*e.g.* use of tan-

talum plate), and laryngectomy with neck dissection; speech problems; bronchoscopy and esophagoscopy; etc.

Registration is limited to 30 Doctors of Medicine in E.N.T. or E.E.N.T,. and the fee is $100.00. Application may be made to: Office of the Dean, Stanford School of Medicine, 2398 Sacramento Street, San Francisco 15, California.

NATIONAL SOCIETY MEETINGS.

Schedule of Meetings for 1956:

Eastern Section, to be held at the Statler Hotel, Boston, Mass., January 13.

Middle Section, to be held at the Netherlands Plaza, Cincinnati, Ohio, January 16.

Western Section, to be held at the County Medical Society Bldg., San Francisco, Calif., January 21.

Southern Section, to be held at the Shamrock, Houston, Texas, January 27-28.

American Board of Otolaryngology, to be held at the Sheraton-Mt. Royal, Montreal, Canada, May 6-11.

American Otological Society, Inc., to be held at the Seigniory Club, Montreal, Canada, May 11-12.

American Laryngological Association to be held at the Seigniory Club, Montreal, Canada, May 13-14.

American Broncho-Esophagological Association, to be held at the Sheraton-Mt. Royal, Montreal, Canada, May 15-16, (afternoons).

The American Laryngological, Rhinological and Otological Society, Inc., will hold its Annual Meeting at the Sheraton-Mt. Royal, Montreal, Canada, May 15-16-17 (mornings only).

Please make early plans to attend the 1956 Spring Meetings in Canada. Both the Seigniory Club and Montreal present most attractive features for you and your family. More information about the places will be told to you.

Reservations at the Sheraton-Mt. Royal Hotel should be made early by addressing the Reservation Supervisor, 1455 Peel Street, Montreal, P. Q., Canada.

COURSE IN RECONSTRUCTIVE SURGERY OF THE NASAL SEPTUM AND EXTERNAL PYRAMID.

Under the joint sponsorship of the Departments of Oto-Laryngology of the L.S.U. School of Medicine and Tulane School of Medicine a course in Reconstructive Surgery of the Nasal Septum and External Pyramid will be presented in New Orleans March 10-17 (inclusive), 1956.

The course will be given with the cooperation of the American Rhinologic Society and under the direction of Dr. Maurice H. Cottle.

The assisting guest faculty will include the following: Drs. Walter J. Aageson, Fred W. Beck, Max Bornstein, James Chessen, George G. Fischer, Irwin E. Gaynon, Harvey C. Gunderson, Richard B. Hadley, Robert Hansen, Kenneth H. Hinderer, John A. Kirschner, Walter E. Loch, Roland M. Loring, Joseph Ogura, Charles J. Puerillo, Ivan W. Philpott, Ralph H. Riggs, Pinckney W. Snelling, Carl B. Sputh, Jr., and Russell I. Williams.

Applicants must be diplomates of the American Board of Oto-Laryngology. Class limited. Apply to: Dr. Clifford G. Grulee, Jr., Director of Graduate Medicine, School of Medicine, Tulane University, 1430 Tulane Avenue, New Orleans 12, Louisiana.

BRONCHOESOPHAGOLOGY COURSE

The next Bronchoesophagology Course to be given by the University of Illinois College of Medicine is scheduled for the period October 24 to November 5, 1955, under the direction of Dr. Paul H. Holinger.

Interested registrants will please write directly to the Department of Otolaryngology, University of Illinois College of Medicine. 1853 West Polk Street, Chicago 12, Illinois.

Rest comes best to the relaxed patient.

Noludar relaxes the patient and usually induces sleep within one-half to one hour, lasting for 6 to 7 hours. Clinical studies in over 3,000 patients have confirmed the usefulness of Noludar in the relief of nervous insomnia and daytime tension. Noludar 'Roche' is not a barbiturate. Available in 50-mg and 200-mg tablets, and in liquid form, 50 mg per teaspoonful.

Noludar® - brand of methyprylon

Hoffmann - La Roche Inc

Nutley . N.J.

VOLUME LXV OCTOBER, 1955 NUMBER 10

CONTENTS

SURGICAL PATHOLOGY OF CANCER OF THE LARYNX. Joseph H. Ogura, M.D., St. Louis, Mo. - - - - - - - - - - 867

MICRO-CHEMICAL STUDIES ON NORMAL CERUMEN. I. THE LIPID AND PROTEIN CONTENT OF NORMAL CERUMEN AS AFFECTED BY AGE AND SEX. S. P. Chiang, Ph.D., O. H. Lowry, M.D., and B. H. Senturia, M.D., St. Louis, Mo. - - - - - - - - 927

THE MANAGEMENT OF SOFT TISSUES IN TEMPORAL BONE SURGERY. Kenneth McAskile, M.D., Toronto, Canada - - - - - 935

THE ATYPICAL EFFECT OF A HEARING AID ON ONE PATIENT WITH CONGENITAL DEAFNESS. Earl R. Harford, Newark, N. J., and Donald M. Markle, New York, N. Y. - - - - - - - - 970

RUPTURE OF THE BRONCHUS. James L. Sheehy, Captain, M.C., U.S.A., and Alan R. Hopeman, Captain, M.C., U.S.A., San Francisco, Calif. - - - - - - - - - - - - - - 978

ABSTRACTS OF TRANSACTIONS OF THE AMERICAN LARYNGOLOGICAL ASSOCIATION, 1955 SCIENTIFIC SESSIONS - - - - - - 982

DIRECTORY OF OTOLARYNGOLOGIC SOCIETIES - - - - - - 997